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FLIGHT

AIRCRAFT, SPACECRAFT, MISSILES

Official Organ of the Royal Aero Club First Aeronautical Weekly in the World Founded 1909

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Bonanza!

IT is the commendable practice of the Aerospace Industries Association of America Incorporated—and one that might usefully be adopted by our own SBAC—to publish a detailed annual report. The 1959 edition is now being circulated, and it admits a view of the American aerospace industry that is not otherwise to be had.

The president's message has special sections devoted to *General Aviation, The Helicopter Industry* and *Aviation Exports*, and the very first paragraph under the first of these headings has a particular significance. It reads: "One of the brightest spots in the aerospace picture is the increased acceptance of small aircraft for business and utility purposes. The five-year period 1954-1958 has seen the production and sale of such aircraft more than double, reaching 6,414 units, valued at approximately $135m. This trend has continued during 1959. In the first nine months the industry has delivered approximately 5,600 units, having a retail value of $128m, compared to 4,725 units valued at $102m delivered in the same period last year."

The full significance of this paragraph is not apparent until cross-reference is made to the section headed "Exports," which records a decline for the third consecutive year. From these related facts the importance of executive and utility aircraft in America's economy becomes obvious. And what is good for America could equally be good for Great Britain.

Domestic sales, of course, account for a vast amount of this business. Indeed "General Aviation"—embracing all civil flying except the airlines—has become the largest user of America's airports and airways. Based on the trend since 1957 (the last year the Federal Aviation Agency conducted a survey), general aviation in America is now flying at an annual rate approximating 12,300,000hr. For comparison, FAA report that airline revenue hours were 3,546,000 in 1958. The active fleet of business and utility aircraft in America now exceeds 70,000, whereas the airline fleet numbered about 1,900 at the beginning of 1959.

Here, then, is a new challenge of "Go West, young man"—a real call of "Bonanza!" In former years this country has sold executive and utility aircraft to America, and it can do so again. But they must be aircraft with a difference and not merely sound products.

The British Scene

As reported in this issue, Mr Peter Masefield has recently emphasized exactly this point—that there is an overseas market, and in particular a US market, for the right British aircraft. The grapevine adds that Mr Masefield's own company will soon have something firm to offer in the executive field. In a feature article on pages 171-172 a novel solution is proposed to the problem of really practical flying in the gap between the expensive American executive machines and the light two-seaters. Here there is a place, it is suggested, for the flying station wagon, which would not only be roomy, reliable and quiet but would take its occupants all the way to their destination (and not just to the airport).

Attention is focussed on this subject again in another news-item in this issue. The Royal Aero Club has announced, as part of this year's sporting programme, a competition for business and touring aircraft in which the entries will be judged on the basis of economy and speed over a 480-mile course, and in a series of short-field performance tests. Obviously speed is the more important to company executives, while economy must be a prime factor for air touring to make any sense at all. The proportions in which these two desirables are mixed will be the all-important criterion for the new generation of British general aircraft.

FROM ALL QUARTERS

***PROVISIONING TEAM**, representing the US Navy, in consultation with officials of the Martin-Baker Aircraft Co Ltd on the range and number of spares to be carried for fully automatic ejection seats which are now standard for USN aircraft (See "Extra-Continental Studies")*

Five Bright Shiners

AIRCRAFT industry exports have achieved a record total for the fifth consecutive year. The 1959 figure, £156,056,066, brought to £942m the amount earned by the industry in overseas markets since the war, just under £600m of which has been earned in the past five years. Of these totals, spare aero-engines and parts accounted for £282m and £205m respectively. The 1959 total exceeded the previous record figure (achieved the year before) by nearly £2m. New orders for aircraft accounted for some of the total and engines did particularly well, sales amounting to £64½m, an increase of £15m over the previous (1958) record total. Spares for aircraft and engines were a third important factor.

The 1959 total was made up as follows, with the equivalent 1958 figures in brackets:— aircraft and parts £84,334,923 (£98,539,800), aero-engines and parts £64,505,981 (£49,557,723), electrical parts and appliances £3,812,253 (£3,296,857), tyres £806,139 (£624,657) and aeronautical instruments £2,596,770 (£2,081,925). Leading buyers of aircraft and parts were India, £17,054,404; Switzerland, £9,089,428; and Canada, £6,494,100.

Belgium Falls into Line

ONE of the last possible markets for the Northrop N-156F, Mirage III and Saab Draken vanished late last month when the Belgian Council of Ministers selected the Lockheed F-104G Starfighter. Brussels radio reported at the time that the choice was "part of the programme designed to . . . limit the task of the Air Force to tactical support of the land forces." Many of the 170 aircraft required will be wholly or partly made in Belgium.

Previous issues of *Flight* (February 13, 1959, and January 1, 1960) have outlined the plans of Western Germany and Holland to manufacture and operate these aircraft. By far the greater part of the total number required will be manufactured in Europe, but first deliveries (96 in the case of Germany) will be made from Lockheed's California Division. In an effort to rationalize the requirements of the three European nations, and assess their relative ability to produce the aircraft and its equipment, an *ad hoc* working group has been established at Coblenz. At present it seems highly doubtful whether the industries of the three nations involved can provide the many hundreds of aircraft for which financial approval has been given.

The Masefield Policy

HARDLY anything aeronautical (apart from balloons) was not at least touched upon when Peter Masefield, president of the RAeS and managing director of Bristol Aircraft Ltd, lectured to the RAeS graduates' and students' section on January 27. His subject was *Problems and Prospects in British Aviation;* and he was busy talking for two hours, either from his script (illustrated with slides) or in answer to questions. His lecture, and subsequent discussion, ranged from Mach 3 aircraft to lower airline fares, from the Hovercraft to laminar flow, from private aircraft (see editorial comment) to company mergers. His policy for a sound British aviation industry envisaged a defined field of endeavour; strong research and development; financial support; a "fly British" policy; and wider scope for British aeronautics, from sporting right up to supersonic aircraft. The industry's objectives should be "to produce and fly at a profit competitive types of aircraft designed to meet and develop growing demands in both home and world markets." It was in this context, when answering questions, that Mr Masefield opined that we ought to design and build executive aircraft capable of breaking into the American market.

Comparison between the British and US industries bulked large in what he had to say, and it was interesting to note that comparative costs per lb (empty weight) were almost identical, the UK £14 and the US £13.7; but "we've got to be particularly clever if we are going to excel them with our smaller run," Mr Masefield commented. The big question, as he saw it, was whether the British industry could remain in "the Big League" against US and USSR competition, with their huge defence budgets. He emphasized the achievements of the British industry in its five decades, designing and building aircraft which were far ahead of their time. But there had to be some re-thinking, on the right lines. We had to decide what to do about supersonic aircraft: "if the Americans or Russia build a Mach 3 and we make a 2, we are out of business." We had to preserve existing skills in the industry in new people coming up into it; the general (i.e., executive) aircraft business was "a very thriving industry and one we must start looking at in this country"—we had got to get into it. Mr Masefield referred to the Cadman Committee report of 1938—before most of his hearers knew anything about aviation—which, he said, was "just as applicable today"; and reiterated his own points of policy for the aircraft industry's future.

Royal Aero Club Awards

THREE awards for 1959 were announced by the Royal Aero Club on January 28. The club's Silver Medal is awarded to Maj T. W. Willans "for his pioneer contribution to sporting parachuting and in recognition of his gallantry and skill in testing the first barometric parachute opening device and the Folland lightweight ejection seat." The Britannia Trophy goes to No 111 Squadron, RAF (see pp. 176-7), "for their brilliant aerobatic displays throughout the year"; and the Geoffrey de Havilland Trophy for the fastest speed in a race or record attempt is awarded to Sqn Ldr W. R. Gellatly for the 100km closed-circuit speed record for rotorplanes of 190.9 m.p.h. in the Fairey Rotodyne. The presentation of these awards will be made following the club's annual general meeting on March 23.

Extra-Continental Studies

A TEAM from the US Navy Aviation Supply Office recently visited the Martin-Baker Aircraft Co Ltd at Denham to determine the range and number of spares to be carried for Martin-Baker fully automatic ejection seats which are now standard equipment for USN aircraft. This was the first time in the history of the Aviation Supply Office that one of their spares provisioning teams has met at a contractor's works outside the North American continent.

Led by E. J. Piccucci, the team arrived on January 18 to undertake the monumental task of studying all the parts of nine separate ejection seats, involving the examination of about 5,000 drawings. This research, which was expected to be completed by today, would enable the 12 members of the team to get first-hand information about the seats and to make a decision on all the ancillary articles, tools, overhaul manuals, etc, necessary for the servicing of the seats by USN personnel.

Honoured by the Guild

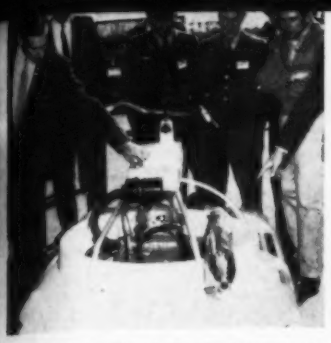
MANUFACTURERS of a navigational system, an ejection seat designer, a distinguished test pilot and a famous flying instructor have been honoured by the Guild of Air Pilots and Air Navigators for their 1959 contributions to aviation. The awards, to be presented by the Duke of Edinburgh as Grand Master at a Guild dinner in London on February 23, are as follows:—

Johnston Memorial Trophy: to the Decca Navigator Co Ltd, whose navigational system, incorporating the Flight Log, "has provided a great contribution to aerial navigation over medium distance routes . . . whilst its long distance equivalent, Dectra, has been impressively demonstrated on . . . flights across the North Atlantic." In awarding the trophy, the Guild "acknowledges a very fine contribution to the technology of air navigation by all those within the company, and those outside who have been associated with its development, especially those who lost their lives during development flying."

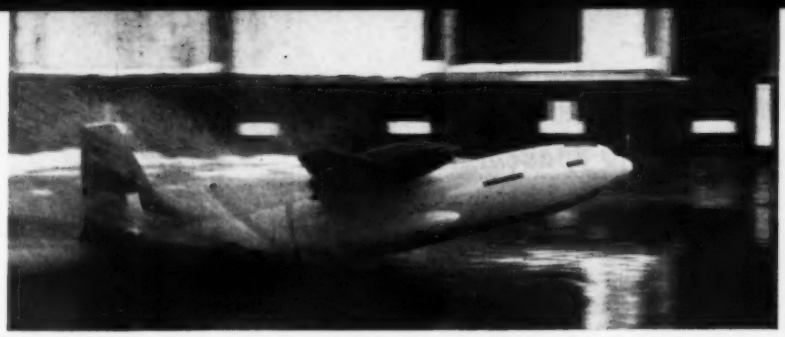
Cumberbatch Trophy: to James Martin, designer of the Martin-Baker ejection seat, which to date "has helped to save the lives of . . . nearly 350 military pilots and civil test pilots." The Guild expresses to Mr Martin "warm appreciation of his contribution to air safety."

Derry and Richards Memorial Medal: to A. W. Bedford, chief test pilot of Hawker Aircraft Ltd, for his "outstanding work in bringing the various marks of Hunter aircraft up to their present stage of development." Special commendation is given for his investigation of the Hunter's spinning characteristics, and his determination and courage in carrying out the tests involved.

Award of Merit: to Wg Cdr C. E. F. Arthur, director of Universal Flying Services Ltd and CFI at Fair Oaks Aero Club, for his services in flying instruction. The award was established in 1958 and is conferred on Freemen of the Guild "for meritorious service as air pilot or air navigator in any sphere of British aviation." It carries with it a silver medal.



INTEREST in the Bell Air Scooter, the lightweight ground-effect machine which is referred to below



DITCHING TESTS of a 1/18th-scale model of the Short Britannic are under way at the works of Saunders-Roe Ltd. The makers state that the aircraft has excellent ditching characteristics and that serious structural failure is unlikely. The model shown has an early form of engine nacelle

Rotorcraft Section Debut

TONIGHT (Friday, February 5) the newly formed Rotorcraft Section of the Royal Aeronautical Society is holding its inaugural meeting at 4 Hamilton Place, London W1, at 6 p.m., when R. L. Cummings Jr, president of New York Airways Inc, is to lecture on *Vertical Transport Business*.

The Helicopter Association has now gone into liquidation and its activities have been transferred to the RAeS rotorcraft section. The Association's former executive council has agreed to serve as the first committee of the section with Prof J. A. J. Bennett, Professor of Aerodynamics at the College of Aeronautics, Cranfield, as chairman of the section committee.

A. V. Roe Canada Changes

THREE managerial appointments in the Aeronautical Group of A. V. Roe Canada Ltd have been announced. They are of Kenneth W. Brown as vice-president and general manager of Avro Aircraft Ltd; John L. Plant as vice-president and general manager of Canadian Applied Research Ltd; and Burton A. Avery as vice-president and assistant general manager of Orenda Engines Ltd. Harvey R. Smith, executive vice-president, aeronautical, A. V. Roe Canada Ltd, remains chairman and president of the three companies, all of which are located in the Toronto area.

"Air Scooter" from Bell

SEEN in a picture above is the Air Scooter, a ground-effect machine constructed by twin brothers employed by the Bell Helicopter Corporation. The latest of many such devices to be constructed in America, it is 85in long, 53in wide and weighs 160lb. A 12 h.p. two-stroke engine drives a fan of about 30in diameter, providing sufficient flow to lift the vehicle about 2½in off the ground. Drawings show the Scooter to have a flexible peripheral underskirt, from which it may be assumed that—as in the Curtiss-Wright Air Car—operation is based on the plenum chamber principle.

Like other firms who are now taking a commercial interest in hovercraft, Bell began work in this field with privately conducted model-studies; the first man-carrying test vehicle was not authorized by the company until the latter part of 1959. The result was this air scooter, said to have achieved speeds of up to 25 m.p.h. and to be capable of climbing a 10 per cent gradient. Control is achieved by inclining the vehicle in the direction of motion; the handlebars appear to have no function other than to carry engine controls and to provide the driver with something to grasp.

Manpowered Flight Defined

FLIGHT around a figure-of-eight course based on two points half-a-mile apart has been set as the main condition for the award of the £5,000 prize offered by Henry Kremer for the first successful controlled flight of a manpowered aircraft designed, built and flown within the British Commonwealth. Regulations for the award of the prize were announced by the Royal Aeronautical Society earlier this week.

Not only must any aircraft entered for the Kremer competition be a Commonwealth product, but the entrant, designer and pilot must be Commonwealth citizens. The aircraft, which must be heavier-than-air, must be "powered and controlled by the crew of the machine over the entire flight," and the use of lighter-than-air gases is prohibited. No device for storing energy is allowed, and no part of the machine may be jettisoned during any part of the flight.

No limit is set to the number of crew members, but "no member of the crew shall be permitted to leave the aircraft at any time during take-off or flight." One ground-crew member may assist at the wingtip during take-off. Attempts must be over "approximately level ground" on a course approved by the Royal Aero Club, and must be made "in still air"—defined as a wind "not exceeding a mean speed of approximately 10kt."

The figure-of-eight course is to be flown around two turning points not less than half a mile apart. The height at the start and finish of the course must be at least 10ft above the ground, with no intermediate height restriction—except that the machine "shall be in continuous flight over the entire course." All attempts must be observed by officials of the RAeC, from whose Aviation Centre at Londonderry House, 19 Park Lane, London W1, entry forms are obtainable.

Project Engineering Group

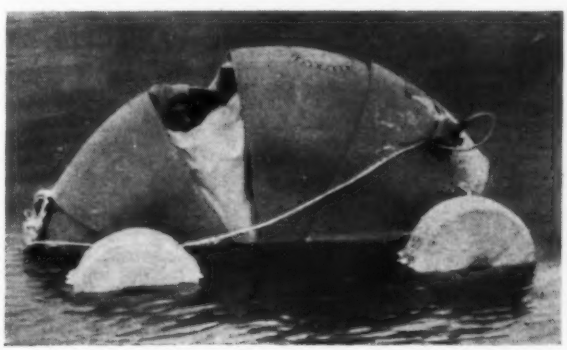
BECAUSE of the need for close liaison with manufacturers, and the ever-increasing complexity of electrical systems, a new project engineering group has been formed by the Aircraft Equipment Division of the English Electric Co Ltd. The company is at present supplying complete electrical generating systems for the Vulcan and Victor B.2s, Canberra, Lightning, Javelin, Bristol 192 and Jet Provost, and individual items of equipment for some 20 different aircraft and missiles.

The new group is headed by T. E. Simms, who joined English Electric eight years ago from Rolls-Royce Ltd, and who now becomes chief project engineer. He and his staff are responsible for all technical co-ordination required on any contract, both externally and internally. Individual project engineers will be responsible for each of various major electrical systems produced by the division, which is a division of the parent English Electric Co and not included in the recently announced merger.

Foreign Aircraft for King's Cup?

THE 1960 air-racing programme was announced at a Royal Aero Club dinner on January 26. Col R. L. Preston, honorary secretary-general, said that there would be three main events: a London-Cardiff air race and short-circuit class races at Cardiff on June 3-4, an air touring competition in May, and a final race meeting at Baginton, Coventry, on July 8-9. It was expected that the London-Cardiff race would be a qualifying event for the class races, which in turn would qualify for the King's Cup race. The air touring contest (expected to be based on Shoreham) would involve a 480-mile circuit and tests of short-field performance; and the King's Cup race and the Lockheed Trophy aerobatic contest would be included in the Baginton programme. A new aspect of King's Cup regulations might be an extension to include foreign aircraft, if flown by British pilots. This, if approved, would call attention to the need for good modern British designs.

Guests of honour at the dinner were the 1959 British air racing champion, Capt N. T. Baldwick of the Army Air Corps, and A. J. Spiller, winner of the 1959 King's Cup race. A replica of the air-racing championship trophy was presented to Capt Baldwick by another distinguished guest, Geoffrey Rippon, MP, Parliamentary Secretary to the Ministry of Aviation, who in the course of an amusing speech reaffirmed that his Minister and he were "very anxious to do all we can to support British private flying."



GUINEA PIG for tests of an experimental survival capsule, Airman Bruce Barwise was the subject on the first day of a three-day test period in the icy waters of Buffalo Harbour. The capsule is intended for the B-58 Hustler, as described on October 16 last

Missiles and Spaceflight

AMERICAN ASTRONAUTICAL SOCIETY MEETING

A HIGHLIGHT of the sixth annual meeting of the American Astronautical Society, held recently in New York City, was a late-evening panel discussion on the subject *Man in Space*. Speaking informally on the topic were some of America's leading authorities in the field of space medicine, and among the more interesting viewpoints expressed during an open question-and-answer session were several concerning Russian man-in-space programmes. It may be recalled that the Soviet delegation to the November ARS meeting (*Flight*, December 4) had been evasive about current Russian man-in-space efforts; that attitude had been maintained despite frequent prior news-items in the Soviet press. What had prompted the Russians to reverse their position and, in some instances, actually to deny the existence of such programmes?

Called upon to answer this question was Brig-Gen D. Flickinger, assistant chief of bio-astronautics for the USAF Air Research and Development Command, who had visited the Soviet Union last summer to discuss their man-in-space work. In the general's opinion, the Russians had changed their attitude—but not stopped their programmes—because of a realization of the admitted confusion which surrounded America's space efforts. Particularly evident to the Soviets was the argument among US civilian and military space agencies as to which should have responsibility for space work. The Russians undoubtedly foresaw propaganda advantages in outwardly divorcing space work from military programmes. Further, the term "astronaut" had begun to have military connotations, and the general therefore expected that when the Soviets renewed open discussion of their man-in-space programme (which he suggested they would do shortly), the emphasis would be on calling their men "space scientists" rather than "astronauts" (or "cosmonauts").

And *when* might the Soviet Union put a man in orbit? Almost certainly this year, stated Gen Flickinger (all of the panel members supported this contention), and perhaps as early as April. Although Russian scientists had last year expressed concern to him over re-entry problems, subsequent successful tests with their "menagerie" had given the Soviets the confidence they required to proceed with a human subject. Would the recently announced mid-Pacific test area (*Flight*, January 22) be the landing-point of their initial flight? Most probably. A re-entry vehicle with an L/D of 0.5, which was certainly within Russian capabilities, could easily land in the designated ocean area after launch from one of the major known Soviet launch complexes.

Was there any truth in rumours (The *New York Times* of December 14) that four Soviet astronauts had been lost so far in man-in-space tests? Not one of the panel members believed the report; nor did they believe a more recent report in a German publication that the first Russian astronauts would be left to die in orbit. The panel were likewise unanimous in agreeing that the Russians' concern for their space pioneers was at least the equal of that of US scientists for the Mercury astronauts. They were leaning over backwards to assure the safety of their men.

Each of the panel members was called upon to express his views on various aspects of space work and, after several members had agreed that it was far easier to make engineering changes than to consider changing the man, Dr T. C. Helvey of Radiation Inc made the startling suggestion that it might indeed be possible to change the man. He observed that the introduction of certain bacteria into the stomachs of laboratory animals had enabled them to digest cellulose (i.e. wood). In time, it might be possible to effect the same change in man.

The remainder of the four-day meeting was devoted to prepared papers on a variety of space topics. One of the more interesting propulsion papers was delivered by Ernst Stuhlinger, formerly of Peenemünde and now director of the Research Projects Laboratory at Redstone Arsenal. Entitled *Space Missions for Ion Propulsion Systems*, the treatise opined that the chemical rocket, "after its triumphant accomplishments with satellites, lunar probes and solar orbiters, may find itself confronted with serious competitors in space within the near future." These competitors would not obviate the need for chemical propulsion systems, but there would be a number of space missions for which engines other than conventional chemical types would prove "more economical, and practical and, in the long run, even more reliable."

One of the competitors was the ion engine, and a number of studies had indicated that the acceleration of ion-powered vehicles would be limited to about 10^{-4}g; however, vehicle payloads, even under those small accelerations, might be as high as 60-70 per cent of the total take-off weight (depending upon the specific mission for which the vehicle was designed). In Mr Stuhlinger's opinion, a first application for an ion engine might be in a communication satellite, stationed in a 24-hour orbit above the Earth's equator. The electric propulsion system, consisting of an array of thrust chambers that could exercise all the different torques and forces, would at first use the major portion of its available power to refine the injection parameters to the required precision. After two or three weeks the communication system would go into operation and the thrust units would draw minor amounts of power as required for station-keeping.

The advantages of the ion engine in the 24-hour satellite application were threefold: (1) the engine was small in size; (2) fuel consumption was low; and (3) the engine could be re-ignited without difficulty as often as necessary. Detailed analyses had led Mr Stuhlinger to conclude that an ion system was superior to a chemical system (in that application) when the total required velocity change during the life of the satellite was over 100 m/sec.

But even more worthwhile uses for the ion engine were noted by the speaker. Engineering data on a family of electrically powered space vehicles were presented and are reproduced below in tabular form.

The travel times to the planets Venus and Mars were hence about the same for ion-powered and chemically powered vehicles (which were assumed to follow minimum-energy transfer elipses). For longer journeys, however, the ion engine showed distinct advantages. While an ion-powered Jupiter probe would take 1.5 years (if launched from an Earth orbit), a vehicle employing chemical propulsion would require 2.7 years to reach Jupiter, assuming a minimum-energy trajectory. In the case of Saturn, the figures quoted for the ion and chemical systems were 2.5 and 6.5 years respectively. A chemically powered vehicle might require 45 years to reach Pluto, while the ion-propelled vehicle could reach the outermost planet within three years—and could travel twice as far as Pluto in a total time of less than four years.

In conclusion, Mr Stuhlinger admitted that ion propulsion systems had not yet reached the engineering stage. "Some basic problems, particularly those of beam neutralization, still require research and development work." However, in view of the substantial efforts now being made to solve the problems, there was no doubt in his mind that the remaining difficulties would be overcome in a reasonable time.

Discussed in another propulsion paper was the *Application of the Nuclear Rocket Engine for Space Propulsion*. The work of H. S. McQueen, A. H. Flagg and C. H. Trent of Aerojet-General, the paper was based upon the simple premise that "the propulsion system selected [for a given mission] should be the one permitting the minimum practical flight time consistent with propellant economy." This implied a high-specific-impulse, high-thrust engine, and it was the authors' purpose to show that the nuclear rocket engine, while massive, provided propulsive forces for space vehicles that would facilitate the carrying of large payloads for less gross weight than was possible with the best high-energy chemical propellants.

To support their contention, the speakers presented data which compared a chemically powered (liquid oxygen and liquid hydrogen) Mars vehicle with a similar vehicle powered by a hydrogen-cooled nuclear rocket. Two chamber temperatures were shown for the nuclear rocket. The value of 3,250°R (with a specific impulse of 700) represented current state-of-the-art

Mission	A	B	C	D	E	F	G
Total mass (tons)	5	72.2	136	435	5.5	10.9	16
Payload (tons)	4.9	50	100	150	1	1	1
Propellant (tons)	0.006	6.7	17	192	2.8	5.9	8.8
Propulsion system (tons)	0.04	15.5	19	93	1.5	4	6.2
Time of propulsion (yr)	0.03	0.08	0.17	1.6	1.5	2.5	3
Power (kW)	5	4,650	5,700	27,900	450	1,200	1,900
Thrust (kg)	0.027	16.9	19.7	46.8	0.75	1.36	1.9
Terminal velocity (km/sec)	0.46	6	10.5	72	90	140	160
Exhaust velocity (km/sec)	38	60	60	120	120	180	200
Initial acceleration (g×10−4)	0.054	2.29	1.45	1.06	1.38	1.22	1.16
Voltage (V)	1,000	2,325	2,420	9,950	10,100	22,200	28,000
Current (A)	5	2,000	2,360	2,800	44.5	54	68

Fig. 1. Characteristic data of ion propulsion systems for various missions: A, satellite correction; B, satellite transfer; C, lunar ferry; D, Mars ship; E, Jupiter probe; F, Saturn probe; G, deep space probe

technology, while the 5,100°R temperature (with an I_{sp} of 900) was shown to illustrate the effect of specific impulse on vehicle performance. Whether or not such a value was achievable in the near future was not disclosed by the speakers.

The Aerojet-General representatives concluded that the nuclear rocket was certainly superior to the chemical engine if multiple re-use of the propulsion system were contemplated; however, even on the basis of a single flight, "the nuclear vehicle yields in the final analysis the most economical system for interplanetary flight within the next one or two decades."

A paper giving *An Estimate of the Nuclear Radiation at the Lunar Surface* was delivered by J. A. Barton of Boeing Airplane Co. By far the greatest danger, he said, was the result of direct solar corpuscular radiation. The dose from that source was time-dependent, however, being present only during the lunar day. It should be absent in the shadows. A much smaller radiation dose was developed from induced radioactivity caused by bombardment of the lunar surface by solar particles. "This should have the same time dependence as the direct radiation, but should be a maximum at the subsolar point, should diminish toward the limbs and be completely lacking during the lunar night except for a small fraction whose half-life is comparable to the lunar period."

The primary cosmic-ray dose, in the speaker's opinion, was independent of location on the lunar surface. Radiation induced by cosmic-ray bombardment and the radiation from decay of radioactivity elements naturally occurring on the Moon were small. In conclusion Mr Barton stated that, pending more rigorous analysis, the nuclear radiation at the lunar surface, assuming moderate shielding and proper site location, was *within* AEC tolerances. "It should be noted, however, that although the weekly dose is within acceptable limits, the genetic damage will probably be increased."

Radiation Source	Weekly Max Dose in Millirems	
	Steady state	Active Sun
Direct corpuscular radiation (PCR and solar corpuscular)	168	100,000
Induced radiation (Neutrons, gammas and protons) ...	0.5	310
Lunar crust radioactivity		
Granite	2.0	2.0
Meteoric material	0.2	0.2
Total	170.7	100,312.2

Fig. 3. Lunar surface radiation doses (Barton)

Genetic effects had been the subject of prior discussion during the previously mentioned "man-in-space" session. Dr Helvey had stated that, if no new radiation belts were detected, and if the astronauts were not too young, "radiation as we know it is not a hindrance to spaceflight." Several other panel members agreed that, for initial experiments at least, the space pioneers should have advanced in years beyond the generally accepted reproductive age.

Taking exception to these remarks, a physician member of the audience suggested that a married man with family responsibilities might suffer periods of depression during a space journey. The married astronaut might be burdened by undue concern over his wife and children back on Earth and the problems which would arise if he failed to return. A much better solution, in the doctor's opinion, was to select astronauts from amongst a group of "robust bachelors." Gen Flickinger disagreed, and ended the discussion by proposing that a bachelor might be even more concerned (and less able to fulfil his duties) because of the prospect of his not returning to Earth "to do all of those things which he had not yet had an opportunity to do."

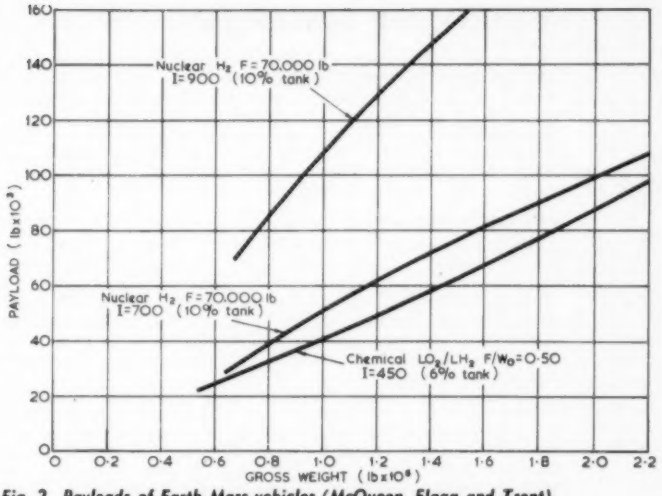


Fig. 2. Payloads of Earth-Mars vehicles (McQueen, Flagg and Trent), assuming 4 per cent excess propellant for nuclear vehicles and 1 per cent for chemical vehicles (F=thrust)

Yet another impediment to space flight was suggested by E. T. Benedikt in his treatise *Disintegration Barriers to Extremely High Speed Space Travel*. Manned exploration of the universe beyond 600 trillion miles (approximately 100 light years) might be quite impossible because of the erosive effects of interstellar dust. Vehicle speeds in the "safe" speed range between 30 and 80 per cent of the speed of light would be required for unrestricted exploration well beyond the limits of our solar system. But, at these speeds, contact with the minutest particles of dust would eventually wear away the surface of any vehicle and cause its destruction. For that reason, although man would eventually be capable of reaching near stars he would never be able to explore the entire galaxy in which our solar system is located.

This news that another insurmountable "barrier" would one day preclude further advances was greeted with some indifference by a number of those present. Having seen such "barriers" as the sound barrier, the thermal barrier and the radiation barrier overcome in recent years, few seriously doubted that future generations would not resign themselves to confinement within some natural "barrier." Barriers have been—and will continue to be—but temporary stumbling blocks which may hinder, but not deter, man's quest for ultimate progress.

DON ADAMS

END OF TERM

It was announced by the Air Ministry on January 21 that at 8.11 p.m. on that day an RAF crew successfully launched a Thor IRBM from Vandenberg. It was the 11th RAF firing, and was significant in that it marked the graduation of the final class of trainees from Bomber Command to pass through the SAC and contractors' training programmes on the missile.

Since Project Emily began in July 1958, 270 RAF officers and 1,520 airmen have passed out on the Thor, and they are currently being assigned to bases at which the IRBM is deployed in Britain. In a message to Maj-Gen David Wade, Commander of the SAC 1st Ballistic Missile Division, George Ward, Secretary of State for Air, said: "This has been a remarkable example of practical co-operation between our two air forces. I am very glad to say that this firing does not mean the end of the association between the RAF and Vandenberg. RAF Thor crews will continue to look forward to their return to this magnificent base." Crews will return to Vandenberg for continuation training; no Thor will be fired in Britain, except in earnest.

GERMANY BUYS SERGEANT

Although precise details have not been made public it has been announced that the West German Parliament in Bonn has accepted a recommendation from the Federal Defence Ministry that the Bundeswehr should be equipped with the Sergeant tactical ballistic missile. Sergeant is under intensive development by the Utah Engineering Laboratory of Sperry-Rand, associated with Caltech's Jet Propulsion Laboratory. It has a range of some 75 miles and is far more mobile and less temperamental than its predecessor, Corporal.

Sergeant itself fits neatly between the spin-stabilized Honest John (12 miles) and the cruise-type Matador/Mace (600 miles plus). As noted on this page in our December 4 issue, the West German and British Governments have jointly proposed that the Blue Water tactical missile under development by English Electric Aviation should be jointly produced by the two countries as a standard NATO weapon. Blue Water is still undoubtedly regarded by most NATO armies as the optimum weapon for Europe, but it cannot be made available by 1961 as can the American missile. It appears, therefore, that Sergeant is regarded more or less as an interim weapon and procurement is unlikely to extend beyond that needed for about three battalions. One obvious objection to the American missile is that, should nuclear warheads be employed, they would not be under the control of the user.

RADIATION-BELT DETAILS

Analysis of data from Sputnik 3 and the Soviet space probes has shown that the intensity of the outer radiation belt around the Earth varies "scores of times," according to a Tass statement reporting a paper by Prof Sergey Vernov. This phenomenon was thought to be related to the magnetic storms which interfere with the circulation of charged particles in the radiation belt.

Prof Vernov said that the outer belt consisted of two main

Missiles and Spaceflight . . .

components—low-energy and high-energy electrons respectively. There was no theoretical explanation for the high-energy electrons, but clearly they must generate powerful gamma radiations which would present a serious danger to future space travellers. According to Sputnik 3 data the height of the base of the outer radiation belt varied at different places with the same latitude—from 600km over the USA to 1,600km over Russia. Maximum height of this belt was 60,000km.

CONTENTS DECLARED

"Informal agreement" on six experiments to be carried out by the first joint US-UK Earth satellite was reached by US and British scientists in Washington last month. An official statement issued after the discussions disclosed that the experiments would comprise "ion and electron studies by probes to measure electron temperature and concentration, and ion mass spectrum; electron density measurements; solar radiation studies; and primary cosmic ray measurements."

The statement added: "The launching vehicle for the satellite will probably be the four-stage Scout rocket which is expected to be operational this year. Although no firm date has been set for the first joint experiment, it is planned for late 1961." British scientists at the meeting were Prof H. S. W. Massey, professor of physics at University College, London, and chairman of the Royal Society's British National Committee on Space Research; Dr A. P. Willmore, department of physics, University College, London; and Dr H. Elliot, department of physics, Imperial College, London.

SPACE BUDGET

A total of $802,000,000 has been requested by the US National Aeronautics and Space Administration for the 1961 fiscal year. This is made up of $167,560,000 for salaries and expenses, $545,153,000 for research and development, and $89,287,000 for construction and equipment. For 1960 the House Committee on Science and Astronautics authorized $530,000,000, but the actual appropriation made by Congress was $500,575,000. A supplementary request for $23 million for that year is now pending.

Addressing the House Committee on January 27, NASA administrator T. Keith Glennan said: "As you know, the President recently directed me to study the possible need for additional funds to accelerate the high-thrust launch vehicle program. As soon as this study has been completed, we will be requesting substantial additional funds . . ." [The figure is believed to be $113m.]

"It is clear that the Soviet Union continues to hold a substantial space lead in the eyes of the world. It is equally clear that this lead is based principally upon the possession by the Soviets of one or more reliable launch vehicle systems having perhaps twice the thrust of our own first-stage booster rockets. This imbalance will continue until we have achieved a launch vehicle system that fully exploits the thrust of the Atlas through the construction and use of properly proportioned new upper stages, or until we have achieved a launch vehicle system which is based on a much more powerful first stage rocket—or both. In no other aspect of the space business do we appear to lag the Soviet Union. In all other aspects, it is my opinion that we have an equal capability and that we have published more significant scientific results, more fully and more promptly than they . . . .

"But this statement does not tell the whole story. The more powerful Soviet launching vehicles make possible their undertaking of some missions that are completely denied to us today. They are able, I should think, to move more quickly from the inception of an idea to the design and construction of payloads because weight restrictions are less stringent than ours. Thus they can avoid the time-consuming tasks of miniaturization, optimum packaging and other weight-saving practices. It is probable, also, that the availability of high-thrust launch vehicles operates to increase the reliability of their flights, since they can undertake significant and spectacular missions with adequate weight-carrying capacity permitting substantial margins for their operations. . . ."

The accelerated booster programme, Dr Glennan said, promised to gain "as much as one year for the complete first phase of the Saturn vehicle." Test dates for two-stage and three-stage Saturn development units would be advanced by 3-9 months. "Despite many expected problems," he continued, "Project Mercury continues to move forward in an atmosphere of confidence apparent to all concerned. Morale is high, hours are long for the top staff, the astronauts are busy and fit. In the third quarter of calendar year 1960 we expect to embark on the man-carrying, Redstone-boosted ballistic training flights. The first manned, Atlas-boosted orbital flight should take place in calendar year 1961."

PUSHING PERSHING

It was announced by the US Army on January 29 that Martin's Orlando Division has been awarded a further contract for $82,599,690 for "continued research and development of the Pershing weapon system." This contract brings the total Pershing vote for Fiscal 1960 to $118,057,000. The money covers the production of missiles, ground-support equipment, training, flight and environmental testing, as well as engineering services and progressive development.

Pershing is a two-stage, solid-propellant, selective-range bombardment missile, designed for maximum effectiveness in mobile battlefield operations. The prime transporter/erector/launcher will be based on the XM474 tracked vehicle, and the support equipment will include primary powerpacks, communications equipment, fire-control (computers, azimuth-laying equipment and other components), test and checkout equipment and the necessary huts and shelters. Captive firing tests at the ABMA are described as "highly successful" and a comprehensive flight-test programme is shortly to begin from a new test facility at Cape Canaveral.

A second Soviet rocket was fired into the Pacific test area on January 31, completing the announced programme. A Tass report stated that the rocket reached the target area at 5.58 p.m. GMT, and that the test was carried out "in accordance with the plan of perfecting a more powerful multi-stage ballistic rocket for the launching of heavy Earth satellites and for carrying out cosmic flights towards planets in the solar system." The statement added: "the dummy last stage of the rocket was visible while it flew through the atmosphere and its fall was registered by ships' radar and an optical and acoustic station. Measurement data again confirmed the high precision of the rocket flight guidance. This completed the present stage of development work."

Three of the four major NASA headquarters departments have been renamed. They are the Office of Advanced Research Programs (formerly of Aeronautical and Space Research), Office of Spaceflight Programs (formerly of Spaceflight Development) and the newly formed Office of Launch Vehicle Programs.

Shooting of a film on space research entitled *Earth-Moon* has been completed at the Moscow Popular Science Film Studio. The film is said to show the trajectory of Lunik 1, the operating principles of the television equipment carried by Lunik 3, Soviet experiments in "studying interplanetary flight conditions," and the launching of a US space probe.

According to Howard K. Smith, a commentator on CBS television, the first operational Atlas at Vandenberg (property of the 576th Sqn) can be fired "19min after President Eisenhower gives the order." This time is surprisingly good, and it should be improved when missiles are emplaced in the revised pad with a side-moving roof.

Since its first experimental firing from Cape Canaveral last May, the Boeing IM-99B Bomarc has run into trouble, and at the time of writing the last five firings have ended in failure. The manufacturer states that the new solid booster has worked perfectly and that the repeated failure has been traced to the control system of the Marquardt RJ43-MA-7 engines.

In a reply to a Democrat who claimed that the US Government planned its defence programme on "hunches," Thomas Gates, the new Defense Secretary, said that "recent statements rating the Soviet missile threat as less serious are based on new and better facts." Previous estimates on Soviet missile production had been based on "ability to produce," but information was now coming in from a "variety of sources."

Herr Walter Ulbricht, Deputy Prime Minister of Eastern Germany, said on January 28 that his government had made a request to the Russian government for the supply of "modern rocket weapons." He implied that these would be of a strategic, nuclear nature; he went on to point out that the locations of West German rocket bases were well known, and that East Germany intended "to be a bit cleverer."

On February 15 "Operation Lookout" will begin in the neighbourhood of Ascension Island, at the impact end of the Atlantic Missile Range. It is an effort to provide further knowledge of what happens during the re-entry of a nosecone. Part of the operation will be the measurement of various parameters by instruments carried in an Avro CF-100 of the RCAF. Two of the big fighters are included in the operation, as well as four scientists from the Canadian Defence Research Board.

As was noted in the description of Minuteman in our last missile review issue (November 6), this new ICBM for the US Air Force will be deployed chiefly from mobile installations. With the approval of the USAF, Boeing (weapon-system integrator) have assigned the design and development of Minuteman railway rolling stock to American Machine and Foundry and American Car and Foundry. The sub-contract, worth nearly $1m, involves the design and development of trucks from which the Minuteman can be launched and a control vehicle which will contain instruments for launching the missile and monitoring its flight. Preliminary design is also required for the launch-car superstructure, including provisions for missile erection and levelling.

National Aeronautics and Space Administration contracts for November 1959 included: Army Ordnance Corps, $480,000 for purchase of Castor solid rockets ($270,000 for Castor development in Little Joe phase of Mercury programme, and $210,000 for Castors to form second stage of Scout); Naval Research Laboratory, $50,000 to study thermodynamic properties of sodium at high temperatures for possible application in nuclear-electric power generating systems; Brookings Institution, $100,000 to study long-term social, technological, economic, political and international implications of space exploration; and Massachusetts Institute of Technology, $50,000 for study contract to describe a proposed advanced development programme for navigational equipment suitable for use in circumlunar and planetary flights.

Sport and Business

STATION WAGON of the AIR

By P. J. DOHERTY

THE need for a new British light aircraft has been the subject of much discussion in recent months. In this article an unconventional approach, in which the aircraft carries its own road vehicle, is made to the problem of designing a practical machine for the private owner. The g.a. sketches on the right are the author's impressions of his proposed aircraft and "cart"; the other sketches with the article show possible developments as suggested by "Flight" artist Frank Munger.

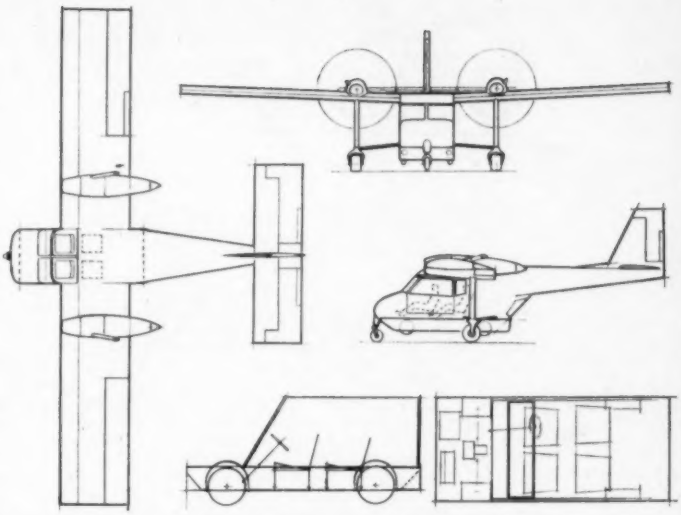
IT is somewhat disappointing to read in the Press that a move is afoot to create a national design for a cheap two-seater aircraft. It was equally discouraging to hear at the recent ABAC dinner a reference by the Parliamentary Secretary to the Ministry of Aviation to what he calls a "touring and training" aeroplane. I am prompted to ask what purpose such a design is really intended to serve. Any successful new design should cover the requirements of many people who, at the moment, have no intention of taking up flying, and should be of such practical value that such people will reorientate their thoughts in this direction. Today's businessman, whether rich or poor, is used to efficient, economical, door-to-door transport; and if such a man is going into the air, he will expect to find a vehicle at least as efficient as the one he is at the moment using.

There are lessons to be learned from the most influential car designs of the past and present, which all have certain things in common. First, they are sturdy and reliable. Secondly, they carry four people. Thirdly, in the more-recent designs there has been accommodation for luggage. An aircraft which is to compete with today's cars has got to be a four-seater with luggage accommodation.

One can go further and suggest that in terms of the car it should be a station wagon, and in flying terms it should be a freighter. There are many thousands of motorists today who could appreciate the finer qualities of a hand-built car but who, in the interests first of price and secondly of convenience, willingly forego these finer qualities in order to buy a vehicle offering greater carrying capacity at the expense of quality of feel. It is for such a man that the new aircraft should be designed.

At the moment we seem to have three categories of aircraft: the expensive executive machine operated by a firm; the light two-seater training and touring aeroplane; and the ultra-light air scooter. There is nothing for the man who can legitimately use an aircraft as a means of transport within his business but who must operate on a limited budget. If he cannot also use his aircraft as a family vehicle he will be most reluctant to embark on what is, at the best of times, an expensive venture.

The purchaser or group-purchaser of a family hack aircraft will put up with much simplification for the sake of economy, but certain qualities are essential. First, the aircraft must be quiet. This is undoubtedly a difficult problem, but the American car of 1956 vintage shows just what can be achieved by steady development. I do not think that anyone expects an aeroplane to be quite as silent as a car, but the difference at the present time is too great.



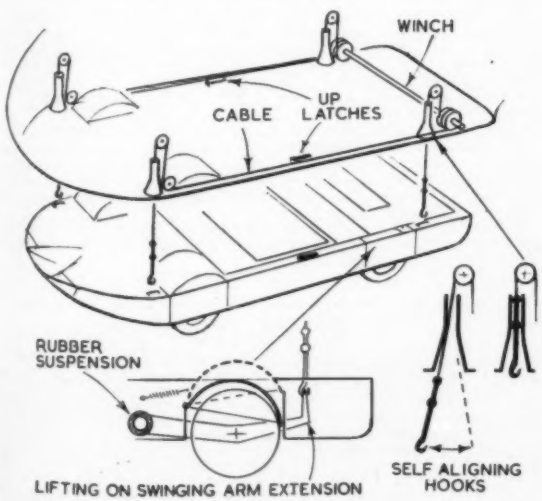
The author's suggestion is for a 42ft-span aircraft powered by two 150 h.p. Wankel engines and carrying a folding "cart" for ground transport at destination (aircraft and cart not to same scale). Gross weight of the combination would be about 4,000lb

A configuration akin to that of a tail-loading freighter would, if price permitted, be wholly acceptable. Entry which would not be impossible for old people is important. It must be possible to stow golf bags or groceries—or polo sticks, brooms, saddles, table lamps, suitcases, a tea chest, a cello, or skis and sticks—without too much difficulty and without too much restriction by weight limits. We may recall that, in the early days of motoring, luggage racks were fitted to the backs of cars—which, when thus laden, appeared to be terribly "nose-up" as the designer had not included any compensation for such loads. A modern aircraft must be able to fly happily with luggage or without, be it an afternoon's shopping or a month's holiday. A high wing is desirable for large doors and ease of loading. A tricycle undercarriage would appear to be the obvious choice. The aircraft must be designed to land on the most difficult terrain, i.e., it must have a strong undercarriage and be capable of landing at a very low speed.

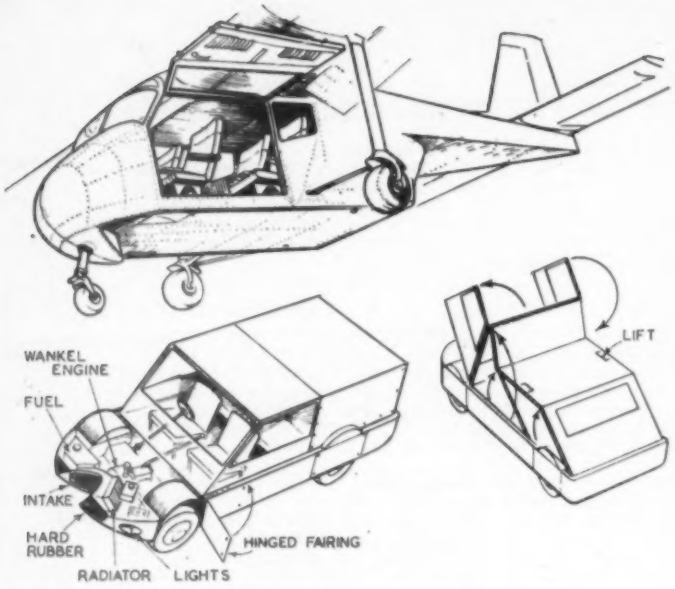
Pilots will tolerate fairly mediocre handling qualities in return for all-round convenience. The man who drives a warm car will expect to fly a warm aircraft; while he will not object to donning flying overalls, he will draw the line at having to garb all his passengers against the elements. Radio facilities must be cheaply available and standardized in the way that telephones are standardized. It is not without a touch of humour that on one side clever development engineers battle to decrease the fuel consumption of an engine by fractions of a pint per brake h.p. per hour, while in another office a gentleman has raised the cost of fuelling this engine by 100 per cent. If aviation spirit could be bought at a proper price there would be little demand for aircraft of 30 h.p. More power means more safety. The present tax, by forcing the employment of small engines, is most evidently lowering the safety factor and encouraging some to think subconsciously that the only aircraft for this country is the light two-seater. I should like to see a basic engine producing not less than 200—and preferably 250—brake horsepower.

A high rate of climb, short take-off, short landing at very low speed (i.e., 35-40kt) and a low cruising speed are essential. Compared with the inconvenience of going by road, it does not matter very much whether we fly at 80 or 150 m.p.h., but it does matter very much that the private flyer of limited experience can know that he can get down easily in low visibility, and climb comfortably out of a confined field. A large fuel tank should be fitted—there is nothing more conducive to cool-headed navigation than the knowledge that one can stay aloft for hours if necessary.

It can be argued that the most desirable engine for a hack aircraft for use both in this country and the outback is an air-cooled, in-line, poppet-valve engine of the type with which we are all familiar. However, the new Wankel engine offers such desirable characteristics that it might be as well to investigate the possibility of employing this unit. Its advantages are high power/weight



Possible winch and cable arrangement for lifting and holding cart. Single-lever release of up-latches, and winch pawl, could allow cart to be lowered to ground under its own weight



Aircraft could have large upward-hinging door for easy access; nose-wheel fairing could seal off cart radiator intake. Cart could have windscreen and light-metal panelled roof and back, erected in single lifting movement or lowered level with top of sides, and canvas side-panels

STATION WAGON of the AIR . . .

ratio, low frontal area, simplicity and, perhaps, cheapness of manufacture. It would appear to be endowed with such qualities as would make possible a cheap twin-engine concept, which is so desirable for over-water crossings and yet might have to be ruled out with conventional engines on the score of price.

One major factor which makes private flying impractical is that there is no reliable link between the point of landing and the point of activity, be it a town centre or a cattle market. An American executive whose annual flying costs total about $40,000 will arrange for a hire-car to await him at his destination, but this is neither economic nor practical for most people. It is therefore imperative that any serious attempt at designing a business aircraft must include a vehicle for "going ashore." We have all thought of putting a Corgi in the back of a light aircraft and, while this might be quite efficient for one person, it remains unsatisfactory for carrying small children, large parcels, or wives of any size.

Two current light-vehicle specifications are of interest here. One, made in Spain, is called the Voisin. This is in effect a small punt chassis with a two-stroke, front-wheel-drive motor and virtually no superstructure. The other is a military specification of the BMC Mini-Minor, known as the Moke and capable of carrying four paratroopers. The Voisin is too short in wheelbase but is endowed with a proper simplicity, while the Moke would appear to be over-specified and too heavy for use as an air tender. What is needed is literally an "undercart," which could conceivably be contoured into the underside of the aircraft; which could be easily unshipped and brought into action; and which would carry four people and their luggage at 30 m.p.h. in reasonable discomfort.

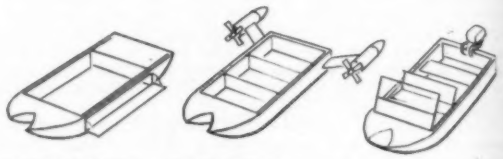
I suggest that a punt chassis with small balloon tyres, without springs, using a two-stroke engine of 250 c.c. or a Wankel, with a folding canvas hood and sidewalls, could be produced with extreme lightness. This vehicle should carry the registration of the aircraft and should not be subject to additional taxation. As is already well known, it is a long walk from Sywell into Northampton, from Wolverhampton Airport into the centre of the town, from Fairoaks or Elstree to Marble Arch, from Burnaston into Derby, or from Sandown into Newport. A ferry car is therefore fundamental to practical flying. If it can be built into an aircraft, flying will be taken up by people with work to do.

The station wagon took many years to evolve; its equivalent will inevitably come into private aircraft design. Can we hope that its convenience will be seized on now and that we can look forward to the day when we can simply step into an aircraft and go? Private flying today is somewhat in the same position as motoring was in the first decade of this century, namely an expensive hobby and not a means of transport. Had motorists in 1910 been told that mile-a-minute vehicles would come on to our roads in 1960 at a rate of 50,000 per month, their disbelief would be understandable. This has happened, in spite of the fact that motorists have been taxed heavily and their money expended on services other than roads and safety.

That we are now building roads which compare favourably with the railways of a hundred years ago is merely because high traffic-volume has enforced action. In the same way, within the next forty years, the saturation of our roads will force the busy man to look to the air, and commercial interests will measure his demand and create the aircraft he needs. The Government now has an opportunity of taking the initiative by co-ordinating the design and production of a common aircraft of really practical specification, and of navigation and safety aids, and by promoting the standardization of maintenance procedures, the requirements of cost reduction coming second only to those of safety.

Since obtaining my PPL I have tried to use existing British light aircraft in a practical way. I have taken my wife and young daughter flying, but conditions were much too cramped and noisy to make it an enjoyable family party. I regret very much that my mother—who has travelled on occasion by camel, bullock wagon, penny-farthing, horse and rickshaw—cannot manage (at the age of 75) to climb into the aircraft which I fly.

About 1933, Hitler asked Porsche to design a people's car. Had he produced a two-seater, history would have labelled such a design as foolish and impractical. In fact, Porsche produced a four-seater car with luggage space. It is now proposed that, in order to encourage practical flying at a reasonable cost, a new two-seater aircraft should be developed in this country. This, to me, is folly. It could in fact ensure that private flying in Britain remains impracticable.



Three possible variations on the cart theme

Postscript: Detail Notes on the Undercart

Suspension Large wheels should be used if possible, for travel over boggy terrain. Suspension could be leading and trailing link by rubber in torsion, or leading and trailing link interdependent suspension as in the 2CV Citroen.

Leading and trailing link suspension with single arms will locate stresses nearer to the centre of the punt, so permitting lighter ends. Assuming 3in bump and 18in wheel, substantial wheel arches are needed. These could be used to locate the cart positively against the underside of the aircraft, and could also substantially stiffen the punt.

Suspension should be such that, when the punt is empty, it should rise on its springs to within 1in of hook-on height; and that it can be raised 1in and depressed 6in by firm hand-pressure. This would enable one man to ship and unship the punt. The stub axles could perhaps be hooked to the aircraft so that the suspension coils are employed to hold the cart snugly home.

Transmission A Wankel engine could be used, operating through one forward gear and reverse, or two forward gears and reverse. Elimination of the differential would improve traction over slippery terrain. Half-shafts could be made to support side thrust and could be built like torque-tubes. One inboard universal joint would suffice if the swing axle was acceptable, and two universal joints would be needed to keep the driving wheels vertical. Rack-and-pinion steering should be used, and means should be found to drop the steering wheel and column for stowage.

Seats should be as in the 2CV Citroen and made to fold forward and downward. The flat windscreen can fold backwards. It would be possible to design lightweight metal side roof and rear panels (see sketch) which could be assembled when needed; but, as this would force the driver to assemble his car every time, the use of easily stowed canvas panels might be preferable. On most occasions the windscreen alone—or windscreen plus roof panel—would probably suffice. Using canvas, one has the contrast of a chassis which must show the sophisticated approach of chassis designer, aircraft designer and aerodynamicist, while the superstructure must have about it the simplicity and apparent crudeness of the standing lug rig of a fishing boat. It must be possible to erect and dismantle the superstructure quickly, with gloved hands, in rain, in a high wind and at night.

I have tried to convey, in these ideas and the sketches, that it should not be impossible for a properly qualified designer to build a vehicle which will fold to a depth of 1ft.

RETROSPECT

From "Flight" of February 5, 1910

Flyers and Politics: Although aeroplanes are hardly likely to be pressed into use for the purpose of taking electors to the poll just yet, it is at least interesting to note that last week Mr Moore-Brabazon decorated his machine with several posters advocating the claims of the Unionist candidate for North Kent, and one just caught a glimpse of what might happen at the next General Election.

CRANWELL'S EARLIEST DAYS

A 40th Anniversary Reminiscence

By J. C. CORLETT

"SUPERNA PETIMUS. The Cranwell motto. . . . It is an ambitious motto, and if we can only live up to it and seek the highest things, whether they be merely top marks in one's class, the highest score in a cricket match, or highest marks towards cock squadron, we are moving in the right direction."

These words, written as an introduction to the first number of the Boys' Wing Magazine, characterize the Cranwell spirit fostered by their author, Air Cdre C. A. H. Longcroft, CB, CMG, DSO, AFC, and his successors.

During the First World War a piece of land was acquired near the small Lincolnshire village of Cranwell for the purpose of training RNAS pilots. Officially titled HMS *Daedalus*, the station opened on April 1, 1916, the choice of date providing inspiration for subsequent wits. By the end of 1918 its area embraced more than three thousand acres and in the intervening period many hundreds of officers had undergone courses of instruction on current types of aeroplanes as well as on rigid and non-rigid airships.

It owes its recognition today to the far-sightedness and clear thinking of one who, as Maj-Gen Sir Hugh Trenchard, GCB, DSO, was reappointed Chief of the Air Staff on January 11, 1919. His principal task at that time concerned the reduction in size of the Royal Air Force and the provision of a scheme for its permanent reorganization on a peacetime basis. Among other recommendations, he proposed the establishment of a Cadet College at Cranwell and Apprentice Wings at Cranwell and Halton for the training of boy mechanics. It was intended that boys of a satisfactory educational standard should be eligible for enlistment from the age of 15½ and undergo a three-year period of training. This scheme was designed to provide a continuous, if small, flow of well-educated young men of high technical proficiency into the various branches of the RAF.

Thus, on February 5, 1920, the Royal Air Force Cadet College and School of Technical Training for Boy Mechanics came into being at Cranwell. The station was then divided into three principal areas: East Camp, housed the Boys' Wing and Technical Training Departments; West Camp comprised the Cadet College and Flight Sheds; and Lighter than Air, the third area, contained a large and a small airship hangar, a number of brick-built barrack huts and a thriving pig farm which was part of the station economy. The huts were occupied only occasionally, when an outbreak of scarlet fever or some such contagious illness required isolation for a period.

The first Commandant was Air Cdre Longcroft, who had already had a distinguished career, having been commissioned into the Army direct from Sandhurst and seconded to the RFC in 1912, after obtaining his Royal Aero Club pilot's certificate (No 192) in March that year. Soon afterwards he made the first long-distance flight by the RFC, non-stop from Montrose to Portsmouth and back to Farnborough in 7hr 20min.

The Boys' Wing was commanded by Wg Cdr C. F. Kilner, DSO, and Wg Cdr R. H. Verney, OBE, was in charge of Technical Training. Wg Cdr Verney had previously been Inspector of Engines, AID, and Chief Inspector in the Ministry of Munitions. His insistence upon quality before quantity, which became the rule of the Cranwell workshops, doubtless stemmed from the valuable experience he had gained in his previous appointments.

Lt-Col A. F. S. Caldwell, DSO, MA, was the first headmaster of the Boys' Wing School and when he was transferred to Halton in 1922 he was succeeded in the headmastership by H. A. Cox, MA, late of Oundle School.

On arrival the embryo mechanics were accommodated in dormitories and their first week was occupied with medical tests, a further examination to classify their educational standard and, for those who survived, swearing-in for ten years' service and two years' reserve. Two suits of khaki were provided, one comprising slacks and tunic with leather buttons for everyday wear and the other a tunic with brass buttons, worn with breeches and puttees for special occasions. The camp barber was kept busy; but, as most of his work was done with clippers, his customers were not kept waiting.

Then followed a lengthy period of daily drill and PT. The instructors in these arts were mostly ex-guards NCOs, and the standard in arms drill, marching, saluting and general bearing was aimed at Brigade of Guards' level. It was generally conceded that this aim was achieved, and in 1921 a detachment accompanied by the Boys' Wing band—trumpets, flutes and drums—gave a display of drill and marching at the Royal Tournament, Olympia, which was widely acclaimed.

These same NCOs evidenced a curious unwillingness to accept some of the new titles of rank which had been introduced with the amalgamation of the RFC and RNAS into the Royal Air Force on April 1, 1918. The CO was always referred to as Colonel Kilner and squadron leaders were called major. Flight lieutenants, however, were always flight lieutenants and flying officers were called "Mr."

When proficiency on the barrack square had reached an acceptably high standard, technical training was begun and the boys got their first introduction to the theory and practice of such trades as fitter aero-engine, jig and tool and motor transport, carpenter-rigger, coppersmith, turner, fitter armourer and draughtsman. Meanwhile, their classroom studies continued as they had previously done, between drill and PT periods. They learned by practical experience to erect and rig a D.H.9A, Bristol Fighter and two Avro 504Ks. A Monosoupape engine which had been reconditioned in the training workshops was installed in one of the latter and a number of boys had an opportunity of air-testing the efficiency of their work. A Vickers Vimy was allotted from Henlow on February 9, 1922, and many boys enjoyed their first air experience in it.

By now some thought was being given to spare-time activities, in addition to sport. A reference and lending library, which had earlier been established, was extended; a literary and debating society was formed under the presidency of the headmaster and administered by a committee of Leading Boys. This was quickly followed by the Boys' Wing engineering society, a camera club, rifle club, music society, wireless society and a model aircraft club.

The long-awaited air-force-blue uniforms became available and were issued in exchange for one suit of khaki. The other was retained for everyday wear and, though the issue of "best blue" had been eagerly awaited, much disappointment was expressed at its inferior quality. The tunics were ill-fitting and the breeches, unlike the well-cut cavalry type which had been handed in, were little more than baggy knickerbockers. The puttees were of the same coarse material and suffered from the added unattractiveness of frayed edges, while the greatcoats could only be described as voluminous.

A bold and somewhat knowledgeable lad set to unpicking seams, pinning here, cutting there and sewing up again. A flat-iron was somehow acquired and soon he was in business (spare time), a walking advertisement for his own tailoring skill. He soon had his copyists, whose dexterity improved with each garment tackled, until eventually they had sufficient confidence to alter their own. These, for a time, were the barons who were enviously seen on a Thursday night entertaining themselves and sometimes charitably extending to their less fortunate brothers the price of "tea and wads" at the YMCA.

An enterprising shopkeeper in Sleaford got in a stock of Fox's puttees in air force blue. They were made of smooth cloth and cunningly cut so that they moulded themselves to the legs; but their wear on parade, except by officers, was quickly forbidden and the struggle to achieve a presentable appearance with the standard issue was resumed. Puttees had to be worn so that their top spiral finished two fingers' width below the kneecap, and the end of the puttee had to coincide with the seam of the breeches (a point for examination on parade inspections). Puttees were cursed things which refused to conform to any known law. If in putting on these "horse-

The Vickers Vimy allotted to Cranwell from Henlow in February 1922

Wg Cdr L. W. B. Rees, VC, OBE, MC, AFC (left), Assistant Commandant of the RAF Cadet College in 1920; above left, Wg Cdr C. F. Kilner, DSO, OC the Boys' Wing in 1920; and above right, the famous Boys' Wing Band in 1922

CRANWELL'S EARLIEST DAYS . . .

bandages" a start was made on the inner ankle bone and the end of the puttee then finished in line with the centre of the kneecap, it was logical to assume that unwinding and bringing the starting-point around to the centre-line of the bootlaces would result in finishing at the required position. Alas for logical assumption! It would now finish either at the back of the knee, or (more frustrating still) within an inch either side of the seam. In order to avoid unsightly pockets around the calf it was necessary to wind them tightly, which felt a little uncomfortable and restricting at first; but after twenty minutes' marching with no blood circulating below the knees, the discomfort became acute. Some research was applied to this problem and it was eventually proved that if they were first thoroughly damped, then carefully wound on and allowed to dry on the legs, the cloth took a permanent set which, provided you remembered to mark "R" and "L" permanently on the insides, would enable them to pass the critical eyes of Leading Boy, Flight Sergeant, Flying Officer, Flight Lieutenant and Wing Commander in successive inspections before church parade.

Church service was held originally in the gymnasium at West Camp but later a hangar was converted to a church, and there can never have been another quite like it. "I" hangar was originally filled with captured aircraft from the 1914-18 War and was out of bounds to members of the Boys' Wing. Perhaps there was a subtle reason for this, because it thus became a "must" for a clandestine visit which could be achieved by squeezing through a gap between the doors; and a most rewarding time, full of technical interest, could be had there on a summer evening.

The aircraft were eventually removed and broken up; and the alterations, which resulted in a beautiful church, capable of seating comfortably the full complement of the station, were completed. The whole interior was painted in air force blue with the bracings picked out in black. At the east end a platform two or three feet high was built to accommodate the choir and the Cadet College band, which took the place of an organ. Beyond the platform the sanctuary, simply designed in new oak with small blue curtains following the platform outline, had as a background a large hanging curtain in a rich shade of red, above which a blue pelmet carried the Cranwell motto *Superna petimus*. The altar cross was a truncated four-bladed propeller. Other complete four-bladed propellers of polished mahogany were suspended horizontally from the roof and carried pendant lighting.

The font at the west end was similarly unusual—an upturned rotary-engine cowling, complete with nine polished cylinders radiating from a centre which comprised the bowl of the font, and supported by four truncated polished mahogany propellers, the whole assembly standing on a mahogany plinth.

The church was formally dedicated to St Michael and All Angels by the Bishop of Lincoln in the autumn of 1921. In his sermon the bishop said that he had never before been called upon to dedicate such a remarkable building; he referred to the prestige and great future of the RAF and to the hopes England was building on the increasing numbers of young men who would be regularly drafted from Cranwell.

The results of the passing-out examinations of the first entry showed the need for an extra period of training in certain technical subjects, which was concluded in May 1923, and concurrently a modified advanced course was held with a view to selecting a certain number of boys for promotion to NCO rank. As a result of the course, nine were promoted to the rank of corporal; and of these, four were recommended for future training as NCO pilots.

The Air Council awarded three cadetships to the boys with the highest honours in all subjects. Of the remainder, almost 50 per cent achieved the rank of LAC. On being posted to various RAF units, the ex-boys found they got a mixed reception: some of the old sweats tended to sneer at "Trenchard's brats" and to resent the authority of the corporals and LACs. However, what they may have lacked in experience was amply compensated for in tact and tolerance, for the very conditions they encountered had been foreseen before they left Cranwell, and they had been carefully schooled on how to meet such situations.

The passing-out examinations at the completion of training were followed by a ceremonial parade which was taken by an Air Staff officer who afterwards presented prizes and addressed the boys. The fourth entry of Aircraft Apprentices, as they then were designated, completed training in the summer of 1924 and the reviewing officer on this occasion was Air Chief Marshal Sir Hugh Trenchard himself. After the parade the whole Wing assembled in the cinema to hear the Apprentices' Wing CO, then Wg Cdr R. J. F. Barton, OBE, read his report, after which "Boom" addressed the assembly. The famous voice which earned him his affectionate nickname reverberated from the bare brick walls.

"I have been shown some of your notebooks," he said in his talk. "Beautiful pieces of work, neatly written on clean pages and carefully illustrated with coloured inks."

The smug satisfaction with which these remarks were received by those who considered themselves eligible for praise was quickly dispelled as he continued in even gruffer voice: "But I don't want to see clean notebooks and coloured inks. I want to see soiled, well-thumbed notebooks with pencilled freehand sketches."

The burst of enthusiastic hand-clapping and foot-stamping which followed this observation was instantly silenced as the great man roared: "Be quiet! I haven't come here to make a popular speech!"

The remainder of his address was listened to in such respectful silence that at the end no one dared to applaud until the CO and platform party indicated by example that it was in order to do so.

Halton Takes Over

The first entry of aircraft apprentices to Halton was in January 1922, and in the ensuing years it gradually supplanted Cranwell as the principal training establishment for aircraft apprentices. Meanwhile, the Cranwell boys were making their mark wherever they served at home and abroad, many of them achieving promotion to higher ranks. With the exception of the three or four from each entry who were awarded Air Council Cadetships, the expiry of their enlisted period from 1930 onwards faced them with the problem of "taking their ticket" and starting a new career in civilian life or signing-on for a further twelve-year period.

The scales were weighed heavily against making a Service career, for this was the time of the disarmament conferences. The rising tide of unemployment, associated with worldwide trade depression, promoted little enthusiasm for spending money on air defence, so the rate of promotion in the RAF was discouragingly slow.

In 1935, however, the picture began to change. Germany had withdrawn from the League of Nations and was known to be rapidly building up her air strength; and, as the threat of another conflict loomed larger as time went by it became clearly inevitable that Great Britain could not afford to lag behind.

Now the Trenchard plan began to show its real worth. The ex-aircraft apprentices who had elected to stay on in the RAF found well-deserved promotion at a rate far exceeding their most optimistic expectations. When the nation at last began fighting a war for which it was ill-prepared there can be little doubt that survival was due to adherence to the policy laid down in 1919.

Nor must the contribution of those who had gone back to civilian life be overlooked. Some rejoined the RAF, others brought their skill and experience to bear on the problems associated with increased output from the factories and the repair and testing of engines and aircraft.

Among the top ranks in the RAF today are many ex-Cranwell boys; and they also have a fair representation among the senior executives of the aircraft industry, with which is included the principal air lines, the AID and the ARB. Like Cranwell's, their motto has always been *superna petimus*.

Straight and Level

NEWS-AGENCY reporters are regarded, justifiably, as the backbone of the news business—reliable, impartial, accurate recorders of fact. So much so that when a garbled agency message gets through it is quite an event. Here's a recent example, only slightly abbreviated, which is *not* for the textbook:—

"Edwards Air Forczhbase, California, Jan 24—The X-15 rocket plane . . . has made a successful powered flight here. The sleek hypersonic plane yesterday reached an altitude of more than 60,000ft, and a speed in excess of 1,400 miles an hour before coming in tola landing on a desert airstrip.

"Crossfield, 1whm was at the controls of another model of the X-15 on the last powered flight attempt, spoiled byh nbjwre in the engineo said later, 'It'blgood to be back in the saddle again.'

"The X-15 hwas dropped from beneath the wing of a giant B,)'35?9.?34-5 45,000 feet and flew under its own power for nine minutes bojmre it landed. The dart-shaped plane is designed to reach more than 3,60m.p.h. at heights of up to 100.000."

Nbjwre in the engineo! Good gracious me, I reckon that's enough to B,)'35?9.?34-5 any flight.

● I see that MEA are now advertising "jet-powered" Viscounts. And BOAC, in a recent Britannia pamphlet, presented the "Britannia Jet." Oh yes, and Pacific Southwest Airlines of California now paint on the white tops of their three Electras the words "Electra JET."

● From a letter in *Daily Telegraph*:—

"Much as we sympathise with the Fairey Aviation Company who have spent so much money on developing the Rotodyne, the prospect of it being flown in the densely populated London area is too awful to contemplate.

"It would have to fly below 1,000 feet to avoid fixed-wing aircraft entering and leaving London Airport. At this height the noise emitted will be so brain-searing that the infamous Boeing 707 will sound like a gentle caressing murmur in comparison.

"It will be too late once the site has been chosen and permission to operate granted —so all those who value their sanity should proceed at once to write to me, their M.P., their local councillor and the *Daily Telegraph*."

* * *

If, only a few years ago, you had said to an aircraft designer or an airline president that his new project was likely to be too noisy he would probably have dismissed the idea as absurd. He would not do so today. Public hostility to aircraft noise is now militant enough to affect the basic design decisions now being taken in civil aircraft project offices by every manufacturer.

I hope, and expect, that the Rotodyne will be effectively silenced. Not so the big jets, which I fear may actually be forced to desert those airports with neighbours who are likely to test their rights to an undisturbed night by means that an eminent British jet designer has termed "mass legal action." We shall see, and it won't give me or anyone in the aviation business any satisfaction whatsoever if this prophecy comes true.

● I see that American Machine & Foundry Co, who claim to be the world's largest producers of launching equipment for guided missiles, have installed a ten-pin bowling alley system at what used to be the Super Cinema in Stamford Hill, London. "A great contribution to human happiness," commented Frank X. White, company vice-president.

Now before you chaps start speculating on Mr White's middle name, let's take a look at a recent American Machine & Foundry news release headed AMF BUILDING BOWLING PINSPOTTER SERVICE FACILITY IN WEST GERMANY.

This new facility, located near Wiesbaden air base, will contain a model bowling lane with Automatic Pinspotter, classrooms, maintenance shops and offices. "Courses in both English and European languages will be conducted in maintenance of bowling equipment, proper management procedures and organization of bowling centers and conduct of bowling leagues," the handout says.

And don't run away with the idea that this is a small-time operation. "The AMF Pinspotter machine course will be under the supervision of US-trained technicians, and the managements and maintenance courses will be directed by two former US Army directors of bowling."

I can report that Britain's lead, however, will once more be assured. As my US columnist friend Erring B. Newscone would put it:—Top-level talks reveal new RAF appointments now slated; predicated Airministry reshuffle rumored to include Director of Poker and Pontoon, Inspector-General of Draughts and Chess, and Commandant-General for Canasta, Snap and Tiddly Winks.

● Members of our Royal family are so untainted by political or commercial controversy that it comes as a bit of a shock to hear foreign Royalty waxing controversial in this field. Prince Bernhard of the Netherlands charges Pan American with blocking KLM's desired landing rights in California (see page 188). He reckons it is because Pan American is afraid of KLM. He has had the "bad luck" to experience American service.

With those remarks, I imagine, chauvinism in international air transport reached its loftiest peak. Thinks: Pan American fears no airline, not even KLM. If KLM get Los Angeles, PanAm will just buy the place up.

● Do you remember when the Americans were offering a king's ransom to any hero or renegade who would deliver a Mig-15 into their hands? Well, I'm sure that any Communist country would now be happy to supply this version (see picture) to help thaw out the cold war.

The Mig referred to above is in Czechoslovakia, and the picture-caption apprises me as follows: "At the Prague airport Ruzyne there is regular traffic no with standing dens snowing and frosts. Runways are clean and dry an all planes big jet planes included are landing safely. A jet plane engine mounted on a truck chasis defrosts runways by flame and hot air."

● By now almost everybody knows that the DC-8 has been proving slower than was estimated, and believes that the Douglas jet is still slower than the Boeing 707, despite what United say (see page 188). Though I always feel that anyone who makes a joke at the expense of Douglas won't have the last laugh, I reproduce the following story from the American magazine *Airlift*.

Passengers on board a TWA 707 *en route* from Los Angeles to Washington heard the captain announce over the loudspeaker: "Ladies and gentlemen, if you will look out of the right side of the aircraft in a few minutes you will see one of the most beautiful sights in America . . . a DC-8 which took off from Los Angeles ten minutes before we did."

ROGER BACON

TRIBUTE TO TREBLE ONE

The RAF's premier aerobatic team—111 Sq

111 Squadron (Hawker Hunters)—has been awarded the Britannia Trophy for 1959 by the Royal Aero Club (news item on page 166)

Members of the RAF mountain rescue team in the Middle East, whose successful location of the wrecked USN Mercator is recorded on this page, at a briefing in Nicosia before their departure for Turkey

SERVICE AVIATION

Royal Air Forces and Naval Flying News

Birthday Salute

PAYING tribute for the first time in its history to the birth of a child to a reigning sovereign, the RAF was to fly a Royal salute over London to mark the arrival of the Queen's third child. Taking part were 36 Hunters from six squadrons of Fighter Command: Nos 56, 65 and 111 from 11 Group; 1 and 54 from 12 Group; and 92 from 13 Group. Led by Wg Cdr G. J. Storey, Wg Cdr Flying at Duxford, the Hunters were to follow the Battle of Britain route, crossing at not less than 2,000ft and approximately 400 m.p.h. from north to south and with Trafalgar Square their nearest point to Buckingham Palace.

Senior RAAF Post

AN appointment to the Australian Air Board was recently announced, Acting AVM E. Hay having become Air Member for Technical Services in succession to AVM E. C. Wackett, who retired from the RAAF in December. AVM Hay returned to Australia last year after spending 18 months with the air forces of Britain, Canada and America carrying out investigations on behalf of the RAAF, with emphasis on technical advancements and administration. He attended the 1957 IDC course and, apart from his technical qualifications, is in current flying practice, having completed a refresher course at East Sale late last year on Vampires.

New Sea Vixen Squadron

IT is appropriate to record on this page, facing the start of a full technical description of the D.H. Sea Vixen, that a second RN squadron of these aircraft—No 890—was being formed at Yeovilton last Monday under the command of Lt Cdr W. R. Hart.

The new unit, which now takes its place beside No 892 Sqn (formed at Yeovilton last July), revives the number of one of the Royal Navy's wartime fighter squadrons, equipped with Grumman Wildcats.

This unit formed at Halifax, NS, in June 1942 under Lt Cdr J. W. Sleigh; then in December that year embarked in HMS *Battler*. During 1943 it went to RNAS Machrihanish, and subsequently served in *Argus* and *Illustrious*, supporting the Salerno landings in September. The following month it returned to the UK and until the end of 1943 was at Eglinton, where its strength was increased to ten aircraft. The squadron went out during 1944 to Ceylon, where in August that year it was disbanded.

Thanks to the RAF

BEFORE flying back to the United States, members of the crew of the 7,000-ton American freighter *Valley Forge* called on No 205 Sqn at Changi, Singapore, to meet the Shackleton crews who went to their aid after they had been driven aground in the South China Sea. Rescue gear was safely dropped in shallow water without damage by the aircraft captain, Flt Lt R. Bennett, making his approach at 90ft and only just above stalling speed. The stranded sailors were eventually taken off by a lifeboat from the RN minesweeper *Fiskerton*, which was directed to the wreck by a second Shackleton, captained by Flt Lt J. Tucker. At Changi the American crew were themselves congratulated by the RAF on their intelligent use of the rescue equipment, prompt firing of a distress signal and their employment of lifebelts to make the international ground code signal "all's well" (two Ls).

American thanks have also been expressed to the RAF in the Middle East, for the location by the mountain rescue team from Cyprus of the wrecked USN Mercator 8,000ft up in the Turkish mountains. The aircraft disappeared on January 19 on a flight from Naples to Adana, with 16 people on board, and the US authorities appealed for help. A Hastings of No 70 Sqn spotted the wreckage in a snowdrift, and the mountain rescue team subsequently recovered 13 of the bodies, leaving three members of their team behind to recover the remaining three from the 20ft drift in which the aircraft was buried. Turkish helicopters co-operated in the recovery work.

Assignment in Athens

HAVING been group captain in charge of training at Flying Training Command headquarters since 1957, Gp Capt R. Sorel-Cameron has been appointed air attaché in Athens with the acting rank of air commodore. Before going to Flying Training Command he was on the directing staff of the Royal Naval College at Greenwich, and previously had commanded RAF Cottesmore from 1952 and RAF Feltwell from 1954. He was awarded the AFC in 1944 and made CBE in 1947.

IN BRIEF

A history of No 12 Sqn is being compiled and Fg Off T. Mason, No 12 Sqn, RAF Coningsby, Lincs, would be glad to hear from former members or anyone able to provide material in the form of stories or pictures.

* * *

Two New Zealand airmen, Sqn Ldr L. C. Jeffs and Flt Lt P. Rule, were rescued recently by an Auster of the RNZAF Antarctic Flight after having been stranded beside their wrecked Beaver for more than a week. They were stated to be "little the worse for their ordeal."

* * *

Sgt Tony Watters of the RCAF hung out of a hole in an Argus aircraft in mid-air over Greenwood, Nova Scotia, on January 22 to release a jammed landing wheel. The hole had been cut to enable the crew to release the wheel and Watters, who volunteered for the task, was held by his feet by fellow crew members. The aircraft had 20 people aboard and the trouble developed shortly after take-off when the pilot was advised of a leak in the hydraulic system.

* * *

Flt Lt S. Ward, a navigation instructor on Vulcans at No 230 OCU at Waddington, is to be the RAF member of the British - Indian - Nepalese Services Himalayan expedition which this summer will attempt to scale the third highest unclimbed peak in the world—26,041ft Annapurna II, second-highest peak in the Annapurna range.

* * *

No 3604 FCU, RAuxAF, was last Tuesday being presented with the Efficiency Trophy for units of No 11 Group, Fighter Command, by the AOC, AVM A. Foord-Kelcey. The trophy is an annual award to the FCU in No 11 Group with the highest all-round standard. This is the first time it has gone to No 3604, which is commanded by Wg Cdre A. R. Smallwood and is one of the biggest such units in the country.

Javelin FAW.6s George and Sierra of No 85 Sqn, which is based at West Malling and shortly to be re-equipped with FAW.8s, in flight over Margate

Sea Vixen

THE ROYAL NAVY'S STRIKE FIGHTER

By HOLLY NEAL, BSc, DIC, AFRAeS

"Flight" photograph

IT is a remarkable fact that at the present time the aeroplane with the highest performance in British service is a carrier-based machine, seating a crew of two side-by-side, which was conceived 13 years ago and first flew in 1951. But the de Havilland Sea Vixen is an exceptional aeroplane; it was the first British aircraft designed as an integrated weapon system, the first British aeroplane to become operational with guided weapons and the first fighter of recent years not fitted with guns.

More than any other aeroplane, the Sea Vixen typifies the process whereby a somewhat embryonic prototype may take many years to evolve into an effective operational vehicle. Thirteen years is admittedly exceptional, but the D.H.110 and today's Sea Vixen are only superficially similar. In fact the two aircraft are markedly different in their structure, equipment, weapons, flying-controls, systems and in every other major respect.

To some extent the protracted development must be ascribed to official vacillation, which once resulted in the entire programme being cancelled by the Royal Navy and subsequently by the RAF also. It was only the manufacturer's dogged determination to continue to develop a design which they knew to be good which finally enabled them to persuade the Ministry of Supply and Royal Navy that it was the answer to the needs of the latter Service. Moreover, during the years that the project was in abeyance there were tremendous advances in weapons, fire-control systems, radar and flight instrumentation and, above all, in the integrated weapon-system concept. Thus, when de Havilland were at last able to go ahead with the operational version, the Sea Vixen was a weapon system, and not merely an aeroplane containing some off-the-shelf stores and equipment.

It was in mid-1946 that de Havilland Aircraft started to discuss with the Royal Navy the possibility of a carrier-based all-weather fighter of outstanding performance. For maximum radar and navigational efficiency it was decided that a crew of two should be carried. Since the aircraft was to operate over the sea, twin-engine reliability seemed desirable. For performance, the wing was given the unprecedented sweep angle of 45°. The aircraft was to have a moderate wing loading, for manœuvrability at altitude as well as for deck take-offs and landings; and for the latter purpose highly effective flaps were required. Folded dimensions had to conform to the limitations imposed by lifts and hangars, and the twin-boom layout was chosen in order to reduce both length and, particularly, height. The arrangement chosen also makes possible economical ship stowage, since the high tail-plane gives ample clearance for the following aircraft to be run forward beneath it. Moreover, the twin-boom layout minimizes engine-out asymmetry, shortens the jetpipes and facilitates access.

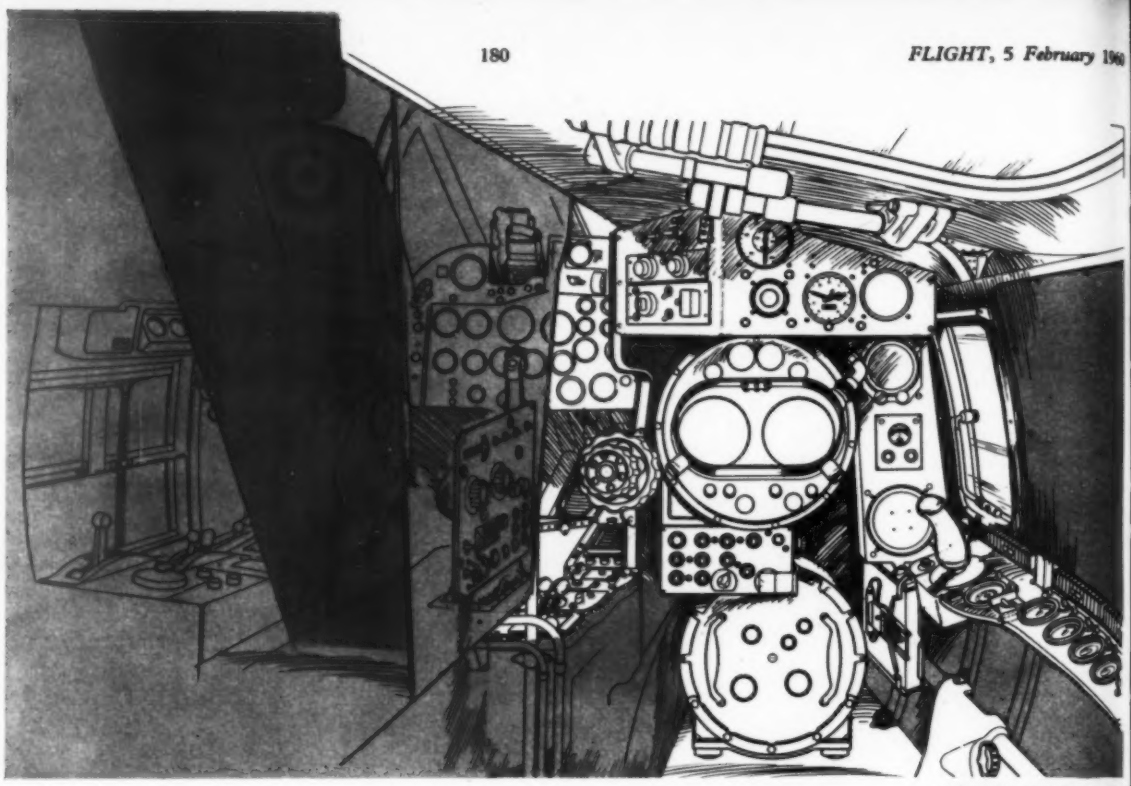
It was around these considerations that the basic D.H. type 110 came into being. Almost simultaneously the F.44/46 night-fighter specification for the RAF was issued (it later was reissued as F.4/48) and de Havilland decided that a non-navalized version of the 110 could be the answer to it. Early in 1947 they submitted tenders for F.44/46 and the Naval N.40/46 specifications. Both tenders were favourably received. Although the subsequent design conferences produced the inevitable uncertainties on armament and equipment, by January 1949 the Ministry of Supply had agreed to place development contracts for seven RAF night fighter and two long-range fighter prototypes, two naval night fighters and two naval strike fighter prototypes. But later that year the first blow fell: owing to political and financial manœuvres, the Navy cancelled their order.

However, that for the RAF still stood and the manufacture of two RAF prototypes went ahead at de Havilland's main plant at Hatfield. The first of these, bearing the serial number WG236, was rolled out in the autumn of 1951 and John Cunningham took it into the air for the first time on September 26. From the outset its behaviour was exemplary and its performance even better than had been expected. By April of the following year WG236 was regularly flying beyond the speed of sound, being the first British aircraft definitely to achieve this distinction. Few who were around at that time will forget the thrill of the small puffs in the sky and the deafening bangs on the ground as this big twin-boom machine demonstrated Britain's entry into a new realm of flight.

Both WG236 and its stable-mate WG 240, first flown on July 25, 1952, were painted silver. Each was powered by a pair of Rolls-Royce Avon RA.7s of some 7,500lb thrust. No provision was made for underwing stores; a conventional tailplane and elevator were fitted, air brakes were provided above and below the jet tailpipes and the 110 at this time can in retrospect best be described as an outstanding basis for development—it was certainly far from being an operational machine.

In 1951, the de Havilland Enterprise took over Airspeed's works at Christchurch, Hampshire, and filled it with assembly lines for Vampires, Venoms, and Sea Venoms. In 1953, development of the D.H.110 was transferred there from Hatfield, under the direction of the chief designer (Christchurch), W. A. Tamblin. (Today, the process has just been reversed: the entire Christchurch design staff has been transferred to Hatfield, although Sea Vixen production remains in Hampshire.)

But while the 110 was still a Hatfield project its story was retarded by two shattering setbacks. In 1952 the RAF chose the



"Flight" copyright drawing

Owing to its unusual configuration the working space inside the aircraft is depicted in this special drawing. It is drawn from the observer's viewpoint; the pilot sits higher on the port side, his ejection seat being shown as a shaded mass, and there is no direct intercommunicatio

SEA VIXEN . . .

Gloster Javelin as the standard land-based all-weather fighter, and this decision left de Havilland with no production order at all, although the company retained their development contract. Then on September 6 came the bitterest of blows: WG236, which had been tremendously impressive during the trade days of the SBAC Show, broke up in the air at the height of a Farnborough Saturday, killing John Derry and his observer Tony Richards and 29 spectators.

After the accident, D.H. carried out extensive structural investigations. An analysis of the aileron stressing cases led the company to conclude that in certain manœuvres the aircraft was undergoing an entirely unpredicted combination of high acceleration and rate of roll. They proved their point by carrying out a wing structural test; the wing failed in torsion at the leading edge, exactly reproducing the characteristics of the flight failure. In the meantime, modifications were put in hand on WG240 to give the necessary increase in torsional strength; and at the same time a number of other improvements were incorporated to give better control at near-sonic speeds. To give better response in pitch in the transonic regime a slab tailplane was provided, and variable gearing was added in the aileron and tailplane primary control circuits to co-ordinate and harmonize response to pilot demand over the very wide speed range of the aircraft.

Late in 1952 the Navy issued a requirement for a multi-purpose all-weather fighter and low-level attack machine to replace the Sea Venom. Although this specification called for a small single-engined aircraft, de Havilland decided to see how well it could be met by the 110. Second-generation Avons would enable the performance to be raised to the level needed (still more powerful Avons are installed in the production aircraft). The airframe would require extensive modification, with increased strength, greater fuel capacity, folding wings, an undercarriage designed for carrier landings, arrester hook, catapult gear, and other changes. Meanwhile, coming into the picture were G.E.C.'s sophisticated AI radar, and Blue Jay (now known as Firestreak) infra-red homing air-to-air weapons.

The Navy liked the idea, and early in 1953 placed a development contract. At this stage the Sea Vixen weapon system had yet to crystallize, but with the introduction of the Ferranti pilot attack sight and a weapon-system computer, the concept of an integrated war machine began to emerge. As in the earlier RAF version, four Aden guns mounted in the fuselage were envisaged as secondary armament, but these were later replaced by rocket batteries.

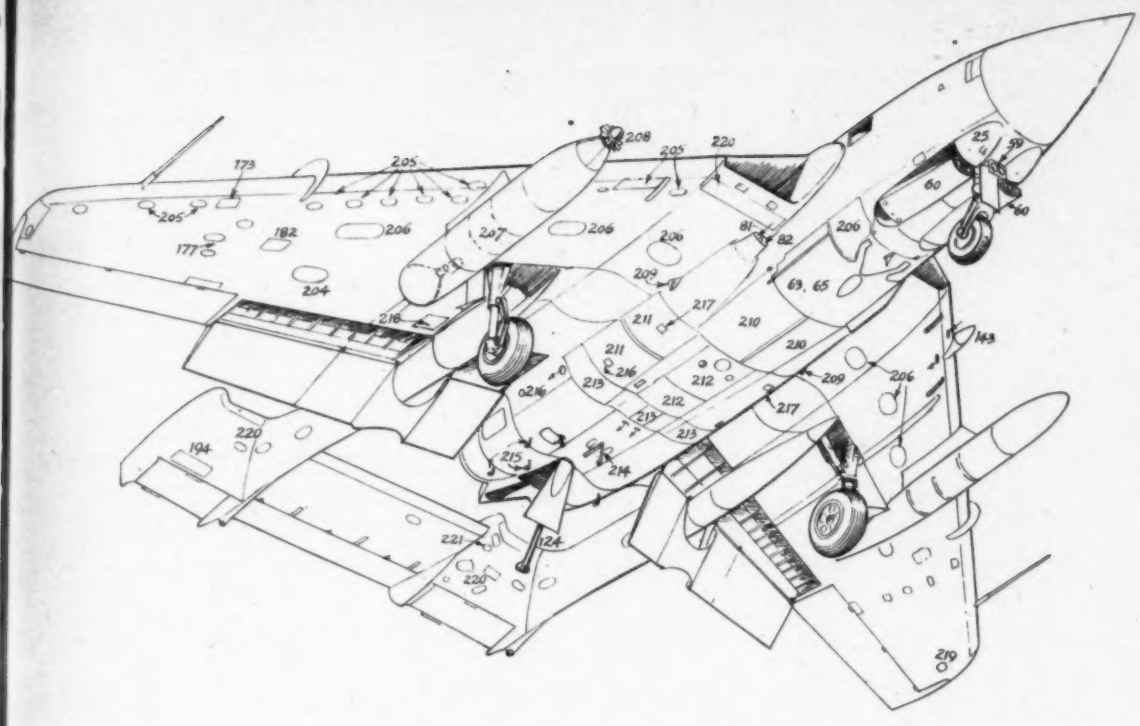
During this time development flying was continuing on WG240 and this aircraft was used to prove the approach characteristics on HMS *Albion*, using "touch-and-go" technique. A "semi-navalized" prototype—XF828, designated Mk 20X—was built in the experimental shop at Christchurch to prove the aircraft for deck operation. It was fitted with catapult and arrester hooks, but not with wing folding or military equipment. The 20X flew in June 1955; but the previous February de Havilland were awarded a substantial contract for the navalized 110, now named Sea Vixen. So, by the time XF828 had satisfactorily completed deck trials on HMS *Ark Royal* in April 1956, production drawings were being issued, and the 110 story was taking a happier turn.

Hatfield carried out the design of the wing fold, the revised tail unit and the longer stroke undercarriage, but the overall responsibility for the redesign was centred at Christchurch. Here the Sea Vixen FAW.1s are now being produced "off the drawing board." The first ten have been allocated to development flying, which has been going on for the past 30 months. The first production machine, XJ474, flew on March 20, 1957.

Principal differences between the Sea Vixen FAW.1 and the prototypes have already been mentioned. The fuselage was largely redesigned to accommodate the new armament system. To conform to length requirements, the upper rear ends of the fins have been cut off and the radome—which is now pointed—is hinged on the starboard side and folds back under hydraulic power (this gives splendid accessibility for servicing the radar and autopilot gyros). Nosewheel steering facilitates manœuvring on deck, and the tail booms have been cocked up to increase ground clearance. Whereas in the prototypes the engines were installed from below, in the production version they are installed through removable panels in the top of the fuselage. Instead of the original upper and lower air brakes a large "barndoor" is fitted further forward in the bottom of the fuselage. This surface was the subject of lengthy *ad hoc* experimentation, and is now a very effective brake without buffet or other unpleasant accompaniments.

Some idea of the amount of development that has to go into a modern combat aircraft can be deduced from a summary of the Sea Vixen clearance-trials programme. The first production aircraft has been concentrating on the fundamental handling problems: getting the controls exactly right, steam-catapult launchings from *Ark Royal* in 1957, flutter checks with drop tanks fitted, handling with Firestreaks, and so on. The second Sea Vixen has been devoted to engineering development: checks of the engine installation, de-icing system, generator cooling, pressure refuelling, operation of the emergency ram-air turbine, transfer of fuel from the drop tanks and jettisoning trials. Perfection of the radar and

(*continued on reverse of fold-out sheet*)



High-energy igniter box
Intake heated by 15th-stage air
Air-conditioning system supplied by 15th-stage air
Ventilating air (ram exhaust)
Cowling support struts
Engine forward-mounting tubes
Engine trunnion mounting
Accessory gearbox and alternator shroud
Gearbox drive shaft
Oil tank
Rear-bearing cooling air outlet
Wheelcase breather vent
Thermocouple leads
Jetpipe trunnion slides
Plessey emergency ram-air turbine
Extension spring for (107)
Flap ram and cable-drum
Actuating cables
Terminal pulley and spring-strut
Torque shafts and gearboxes
Sprockets and roller-chains
Bogies on divergent rails
Flap-tailplane-tab interconnecting cables
Flap-up catch access (port flaps up, disconnected)
Flap-rail fairing

118 Dog-clutch to outer flap
119 Flap interconnecter
120 Flap tailored to boom contour
121 Hydraulic reservoir
122 Hydraulic accumulators
123 Hydraulic header tank
124 Arrester hook and jack
125 Access in wheel-bay to (121 and 122)
126 Fire-extinguisher bottles (12lb)
127 Inward-retracting main gear
128 Dunlop wheels, tyres, Maxaret and disc brakes
129 Jacking/towing point
130 Side stay
131 Leg pivot members
132 Retraction jack
133 Spring-strut
134 Door actuator and linkage
135 Stores-pylon castings
136 Firestreak guided weapons
137 Winching attachment
138 Glass fairings over seeker head
139 Windows for IR proximity-fuze system
140 Autopilot unit
141 Stub boom
142 Heavy-gauge doubler plates
143 Flight Refuelling probe

Wing Fold

144 Forged rib
145 Front and rear hinges
146 Wing-fold jack
147 Bracing tubes
148 Lift linkage to outer wing
149 Horizontal latch
150 Vertical latches (three pairs)
151 Latch-pin jack and linking frame
152 Sequence valves
153 Connecting rod to rear latch pins
154 Fuel feed and vent swivel couplings

155 Electrical trough
156 Cables for manual locking
157 Aileron control transfer mechanism
158 Leading-edge locating spigot
159 Hydraulic hoses
160 Fold fairings
161 Fold-fairing hinges

Starboard engine (also see 76, 77 98, 99)

162 Bleed-valve discharge
163 Pneumatic starter in nose fairing
164 Inlet-guide-vane actuator
165 Anti-icing air bleed
166 Slinging eyes
167 Exhaust-unit drain
168 Jetpipe clamp

Outer Wing

169 Fuel cells
170 Extruded rib booms with tubular bracing
171 Tank pylon casting
172 Aileron push/pull rod
173 Aileron spring-feel unit
174 Aileron-trim electrical actuator
175 Autopilot actuator
176 Centering strut
177 Aileron power unit
178 Aileron drive point
179 Dog-tooth and fence
180 Pitot head
181 Aileron mass balance
182 Kelvin Hughes air mileage unit
183 Skin doubler
184 Fuel fillers

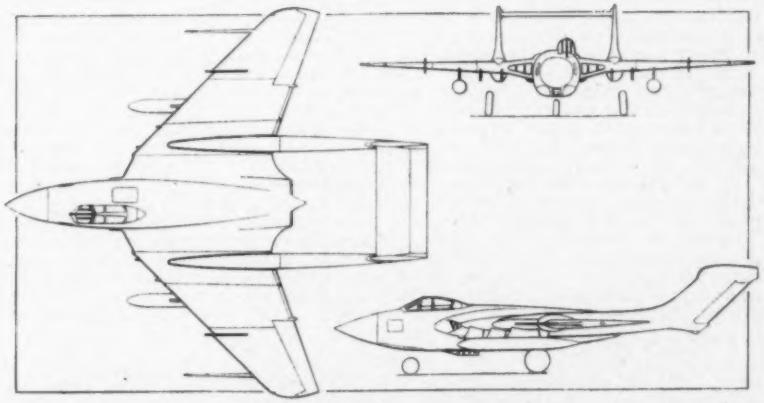
Booms and Tail

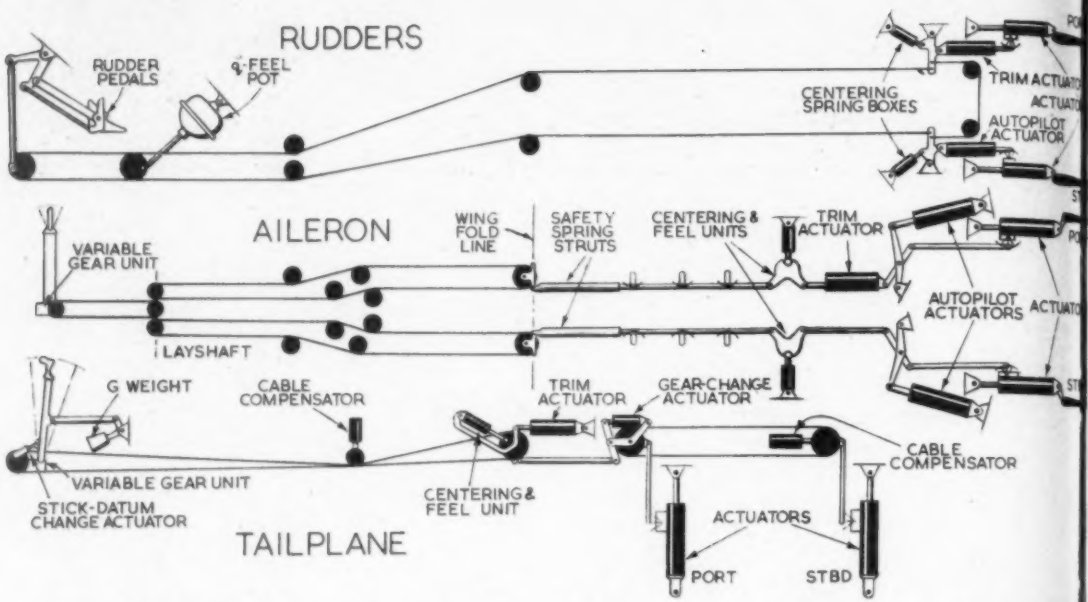
185 Joint rings
186 Internal doubler

187 Two Rotax inverters (each boom)
188 Cooling air to (187)
189 Telebrief socket
190 Air bottles
191 Hydraulic accumulators charging point
192 Bumper strut
193 Trestle/lashing point
194 Flat-based fairing
195 Tailplane power unit, link and guide
196 Fulcrum casting
197 Tab linkage and cable from (115)
198 Trim group and interconnect cables
199 Rudder power units
200 Torque shaft and mass balance
201 Tab mass balance
202 Rudder input cable
203 Cable linking (199) port and starboard

Underside view

204 Booster-pump access
205 Electrical access
206 Structural access
207 Flight Refuelling pack and drogue
208 Ram-air turbopump for (207)
209 Catapult hooks
210 Access to fuel, air-conditioning and electrics
211 Powerplant access
212 Gearbox and access to (163)
213 Access to hydraulics
214 Catapult hold-back anchorage
215 Drains
216 Fire access
217 Radio-altimeter aerial
218 Pressure-fuelling panel
219 Compass detector unit
220 Access to flying controls
221 Access to tailplane gear change





Few aircraft of the Sea Vixen's size have so complex a flight-control system; it is described in a special section on the next page

sighting systems has been the concern of the third aircraft. Firing of the internal rocket battery, and co-ordination with the pilot's sighting, has been dealt with by aircraft number four; this included intensive landing trials early this year on *Centaur*, together with the eighth aircraft, which was allocated to Handling Squadron for the compilation of Pilot's Notes. Checking the operation of the Firestreak guided weapons has been done on the fifth aircraft. Radio and navigation checks were the responsibility of the seventh. Tropical trials and winterization were carried out respectively by Nos 6 and 9; and final deck trials on *Victorious* by the Service Trials Unit, No 700 Sqn Y flight, by No 10. Following the successful completion of these trials, the Sea Vixen went into service in July last year when 892 Sqn (Cdr M. H. J. Petrie, RN) was formally commissioned at RNAS Yeovilton.

The Aircraft Described

SINCE the comprehensive radar equipment demanded a fairly wide fuselage, it has been possible to provide side-by-side seating for pilot and navigator, thus reducing fuselage length. The navigator, however, is situated at a lower level than the pilot so that he does not require a projecting canopy. Both crew members are provided with Martin-Baker 4DS fully automatic ejection seats, with electric height adjustment.

A large explosive cartridge can jettison the pilot's canopy even when the aircraft is under water, allowing pressure to be equalized both inside and outside the aircraft so that a sequenced air bottle can then blow off the navigator's hatch.

Each crew-member has a single centralized service-connector, including circuits serving ventilated pressure suits and g-suits, the former including means for maintaining comfortable humidity and temperature. Later aircraft are likely to be fitted with a liquid-oxygen convertor, but at present bottles are fitted.

Standard armament comprises the two secondary Microcell rocket packs stowed flush within the lower fuselage. Each houses fourteen 2in rockets, which can be fired singly, "rippled" or fired in salvo while the packs are hinged down hydraulically.

This armament is normally carried with all alternative primary loads. In the normal intercepter role the primary armament consists of four Firestreaks mounted on underwing pylons, two on each stub wing; in addition, two 200-gal droptanks can be carried on the heavy-store pylons on the outer wings. Alternatively, bombs, rocket carriers or launchers, or a mixed load can be carried —in fact, any airborne store in the current Navy repertoire.

As noted already, the Sea Vixen is equipped with the latest G.E.C. interception radar, which provides search, lock-on, blind firing and other facilities, and operates in conjunction with the Ferranti pilot attack sight. Navigational, flight-instrumentation, and communications equipment includes ground and air position indicators, a reference gyro (monitoring the instruments, autopilot and radar in pitch and roll), the latest type of flight-instrument presentation with full freedom about all axes, TACAN, UHF, radio altimeter, and a Louis Newmark autopilot providing height, speed or Mach hold as well as yaw and pitch damping.

The Sea Vixen wing is swept 40° at the quarter-chord line, has a t/c ratio of 10 per cent. Fowler flaps are fitted in sections, one on either side of the tailboom, and another outboard of the wing fold. The undercarriage, constructed by de Havilland Propellers to the aircraft company's design, is stressed for vertical speeds appropriate to carrier operation, and retracts inwards, the doors closing after the gear is lowered. Dunlop Maxaret brakes are fitted, and for deck-taxying the nosewheel is hydraulically steered from the pilot's right hand. The catapult hook is mounted forward and inboard of the wheel wells, and the arrester hook retracts between the engine tailpipes.

Constructionally speaking, the heart of the airframe is the one-piece centre section and stub-wing assembly, which is built by D.H.'s Portsmouth factory. Its main load-carrying portions comprise a forward torsion box (extending right across the centre section forward of the engine bay, and taking the main bending loads) and a rear box, which extends laterally only between the ribs and rib 4 on each side. Fore and aft, the rear box extends from the wheel-well wall to a rear spar, and bending loads are transferred to the main forward box through ribs 1, 3 and 4. Vertical shear and side loads from the rear box are carried across the centre-line by the spectacle beam through which the engine tailpipes pass. The spectacle beam is linked to the forward box by rib 0, the centre-line rib, which extends the full length of the centre section between the engines. The spectacle beam also resolves side loads from the arrester hook, which is mounted at the rear end of rib 0.

At rib 2, just outboard of the engine intake, the wing structure changes both in plan and elevation, and a wide joint strip is Redux-bonded and bolted to the skins on either side. Tail-boom loads come in at rib 3, and are shared between the main and rear wing structures. Rib 3 also carries the main wing-fold jack attachment, the undercarriage side stay and the undercarriage jack attachment; spanning across the wheel well, it is a sturdy member with a strong cranked lower boom. The undercarriage itself is carried on rib 4 and on the rear wall of the wheel well.

The front fuselage (comprising the pressurized cabin, the nose-brake below the pressure flooring and, forward of the front pressure bulkhead, the radar compartment and hinged radome) is mounted on four attachments on the forward face of the front spar. Fore loads only are taken through the top attachments, shear loads being transferred through the bottom fittings. An abutment on the centre-line takes side loads.

Immediately aft of the front spar, above the wing, are the main electrics compartments, accessible through hatches. The engines are installed aft of the main box, the mounting trunnions being located on ribs 1 and 0, with forward pick-up points taking only vertical loads.

Titanium firewalls are provided just forward of the engine mountings, and the webs of ribs 0 and 1 in the region of the

zones (from the rear wall of the forward box to the spectacle beam) are also titanium. Continuous Graviner Firewire detectors surround each engine in the main fire zones between the firewalls and between the rear firewall and the spectacle beam. All the decking above the engines is removable. The panels below each engine are also removable, except between the rear firewall and the spectacle beam, where there is a fixed fairing. Below the engines, and between the front and rear firewalls, spans the accessory-gearbox beam. Each intake duct passes through spar webs and the web of rib 1, and most of it, and the leading-edge intake itself, is double-walled for hot-air de-icing.

On the main box structure the skins are sculptured, thicknesses ranging from 0.25in to 0.128in. On early production aircraft the skins are machined, but contour etching (chem-milling) has been approved for the main wing skins, and has from the start been used for sculpturing the skins of the elevators, rudders and tailbooms. The slab tailplane makes no contribution to the torsional stiffness of the booms, which are consequently required to possess considerable torsional stability. Skins in the region of the rear spar are taper-etched after forming to curvature. Lateral stiffness of the stub booms is increased by reinforcing at the sides with steel laminations extending aft from the wheel-well wall. The joints between the stub booms and the tailbooms proper comprise mating light-alloy forged rings.

The wing-fold rib 4, and its mate 4a in the outer wing, are very substantial, being machined on a Hydrotel from plate some 2in thick. These components are sub-contracted to Short Bros. and Harland, in Belfast. So also is the tailplane, which has a mechanically milled skin.

In each wing-fold joint there are six main attachment points: two hinges, one horizontal top latch and three bottom latches with dual vertical pins. In addition, there is a shear spigot at the leading edge. All latches are operated by a horizontal jack, mounted on a girder structure on rib 4. All the attachment fittings are steel forgings, the loads from which are diffused into the skin by reinforcing members extending over two rib bays. The main 52,000lb wing-fold jack operates through a double linkage, each link being a titanium forging with forged steel pivots.

Each outer wing is a three-cell box out to rib 8, and a two-cell box from there to the tip. Up to rib 8 the skin is machine-tapered from 0.25in down to 0.128in; outboard, thickness is uniform. Rib 8 is the boundary rib of the outer-wing integral tanks. In the stub wing the forward box structure between ribs 2 and 4 also forms an integral tank; Redux bonding and bolted construction, but no rivets, are used in the tank areas. Inboard of rib 2 in the space surrounding the engine air intake duct are interconnected bag tanks. Stores pylons are attached to castings integral with the leading-edge ribs at stations 3 and 4 in the stub wing, and station 5—carrying the heavy stores—in the outer wing. On the port stub wing, a Flight Refuelling probe fitting is cast integrally with a nose rib intermediate between ribs 3 and 4.

Flying Controls

Flying controls on the Sea Vixen present quite a complex picture. Tailplane, ailerons and rudder are fully powered by Hobson dual units, each with one input lever operating two jacks. One set of jacks is operated by the "blue" hydraulic circuit, and the other by the "yellow," the latter also supplying the autopilot actuators. Blue and yellow circuits are completely independent, each being fed by its own engine-driven Integral pump. With one system out of action, the remaining system can supply power. In the event of failure of both engines, the blue circuit can also be fed by a ram-air turbopump, which provides enough power for gliding to a carrier and landing-on. Even without the ram-air turbine and with both engines windmilling adequate control is available at all speeds except on the approach.

All the circuits between the pilot's controls and the surface actuators incorporate spring feel, and the rudder circuit also contains a q-pot to increase the surface stiffness with speed. Except in the outer portion of the aileron circuit, cable runs are used. The rudder circuit runs through both booms, up the fins and across the tailplane spar, and incorporates on each side an electric actuator forming a variable-length link. The starboard actuator, controlled by the pilot, is used for trimming. The port actuator functions as a yaw-damper, and is controlled by one of the autopilot rate gyros.

Control of the tailplane is transmitted through the port boom to the port power unit and thence across the tailplane to a similar unit in the starboard fin. Control movements are transmitted through a variable gear, and there is also a g-restrictor and a q-sensitive viscous damper. Early trials with the slab tail revealed a very great difference in response over the speed range, disproportionately greater stick movements being required at transonic speeds. To overcome this an automatic gear change was incorporated. It is operated by a Mach switch connected to an electric actuator in the fin, which varies the linkage when a given speed is reached. Moreover, at low speeds coarse stick movements were found to be necessary, and to overcome this a third gear change is incorporated.

"Flight" photograph

Banking away to port an aircraft of 892 Sqn displays its quartet of Firestreaks, outboard drop tanks and refuelling probe

The "elevator" is used only as a trimmer in conjunction with the flaps. At normal speeds it is locked to the tailplane, but when the flaps are lowered the elevator deflects upwards to compensate for the trim change and to increase the power of the tailplane. Trimming of the tailplane is effected by a second electric actuator in the port fin. This has dual motors, one running slightly slower than the other and serving as a standby.

Variable gearing is also used in the aileron circuit. From the control column, a cable circuit leads to a pulley forming the lower part of a coupling on the wing-fold rib. Outboard of the fold push-pull rods run along the leading edge. In the event of the ailerons being displaced relative to the inner circuit when the wings are spread, a spring-loaded strut adjacent to the coupling takes the shock. Trimming is effected by an electric actuator operating on the starboard aileron.

It is through the ailerons that autopilot control is exercised, these surfaces working in unison as elevons for pitch control and differentially for directional control. The reason for using elevons rather than the tailplane is that finer control can thereby be obtained. The autopilot actuator operates the aileron jack through a linkage arranged to bypass the spring-feel mechanism. Surface travel under autopilot control is limited. An electronic circuit is therefore arranged to detect any appreciable out-of-trim condition, and signal it back to the tailplane-trim actuator.

The flap circuit is also quite intricate, owing to the wing geometry and the fact that the flaps are in three sections. The flaps are operated by a Lockheed Servodyne in the starboard engine bay. This drives a crank rotating a drum from whence cable runs are taken into each stub wing to a system of gearboxes and torque

When it first flew, the original development was necessary befo

shafts, with a dog-clutch at the wing fold. Chains drive each end of each flap section, and a cable run to the elevator counteracts trim change.

Hydraulics. In all there are four systems: blue and yellow for flying controls and autopilot, and green and red for general services. The green and red are each supplied by a large-capacity Lucas pump at 3,000lb/sq in. Services operated by the green system comprise the undercarriage and doors, wheelbrakes, arrester hook, flaps, and rocket-pack actuator; all of these can in emergency be operated by the red system. Also operated by the green system are nosewheel steering, airbrake, and the wing-fold latch and folding jacks. The red system feeds the parking brake, the radome opening and closing gear, the radar scanner—this component, which absorbs a considerable amount of power, is designed and made by de Havilland Propellers—and a hydraulic motor driving the alternator supplying the AI radar.

Emergency power source for the blue system is the ram-air turbopump housed in the fairing between the tailpipes. Normally it is locked in a retracted position, it can be released mechanically by the pilot, whereupon springs lift it into the airstream.

Each engine drives a common accessory gearbox, on which are mounted two 28V d.c. generators, two Lucas and two Integral hydraulic pumps. One Lucas general-services pump and one generator are independently geared to each engine. The two Integral pumps for the blue and yellow systems are geared together through a free-wheel, and driven from whichever engine happens to be running faster.

All Sea Vixen FAW.1s are being assembled at the Christchurch, Aircraft. Other D.H. plants, notably that at Portsmouth, co

Electrics. The main 24V system is supplied by the two generators mentioned above. The system supplies four 115V, 400c/s inverters, two of which supply three-phase and two single-phase a.c. supplies for the radio, instruments and autopilot. Hydraulically driven alternators provide close-frequency supplies for the guided weapons and AI radar.

Other services fed from the general d.c. system include the flying-control trim motors and gear-change actuators, canopy actuation, stores jettisoning, cabin-temperature control, fuel booster pumps and refuelling solenoid valves and float switches. The 24V system also serves a number of warning indicators, including the central warning panel on which are grouped 15 systems-failure indicators, plus a pair of flashing lights and an audible warning. The two latter are triggered off if any of the 15 systems fail, and the individual warning indicator shows which is faulty. The pilot can switch off the flashing lamps and audible warning, but not the individual indicator. The systems covered by the central warning panel include the generators, flying-control hydraulic pressure, fuel pressure, engine oil pressure, three warnings for the fire zones (operated by the Firewires), wing folding, ASI, oxygen reserve and cabin pressure.

Fuel system. As described earlier, fuel is carried in bag tanks on each side of the aircraft surrounding the air intake duct, and in integral tanks in each stub and in each outboard wing, as well as in the two drop tanks.

The feed to the engines is used to cool the hydraulic fluid driving the close-control alternators; this in turn heats the fuel and prevents the filters from icing up. All the integral tanks feed automatically into the bag tanks, which feed the engines; the pilot has no worries about selection. All the tanks are pressurized, and to ensure feed during inverted flight, air accumulators (recuperators) are provided in each tank.

All Vixens now being delivered are equipped to receive fuel by the Flight Refuelling probe/drogue r reel pod which may be carried in plac converts the aircraft into a tanker. carried externally, can be filled throu and trials have taken place both by da

Air-conditioning. Air bled from t compressors is used for pressurizing and the crew's ventilated suits, canop heating, radar cooling, heating the charging the fuel recuperators.

For the main conditioned air suppl is divided, part flowing through a ra cold-air unit, and thence into a water to the same unit via a by-pass valve. T the cold air unit is regulated thermosta in the main cabin ducts. The conditi the cockpit, part being directed over and part being discharged at the pilot feet. Cabin air is used to cool some forward of the front pressure bulkhea the nosewheel bay. Another bleed led to the light-store pylons for he its temperature being controlled b exchangers.

Air rammed in under the wing roo the cold air unit to cool the engine-c from the cold air unit provide for coo system and fire-control. For cooling t armed high-pressure air is drawn f which also pressurize the hood and ca started by low-pressure air.

w, the original D.H.110 (left) was the fastest aircraft in Britain, and was the first British aeroplane known to have exceeded the speed of sound. necessary before the operational Sea Vixen could emerge. Many superficial differences can be discerned in these photographs, the production aircr

Christchurch, Hants, factory of de Havilland ortsmouth, contribute major sub-assemblies

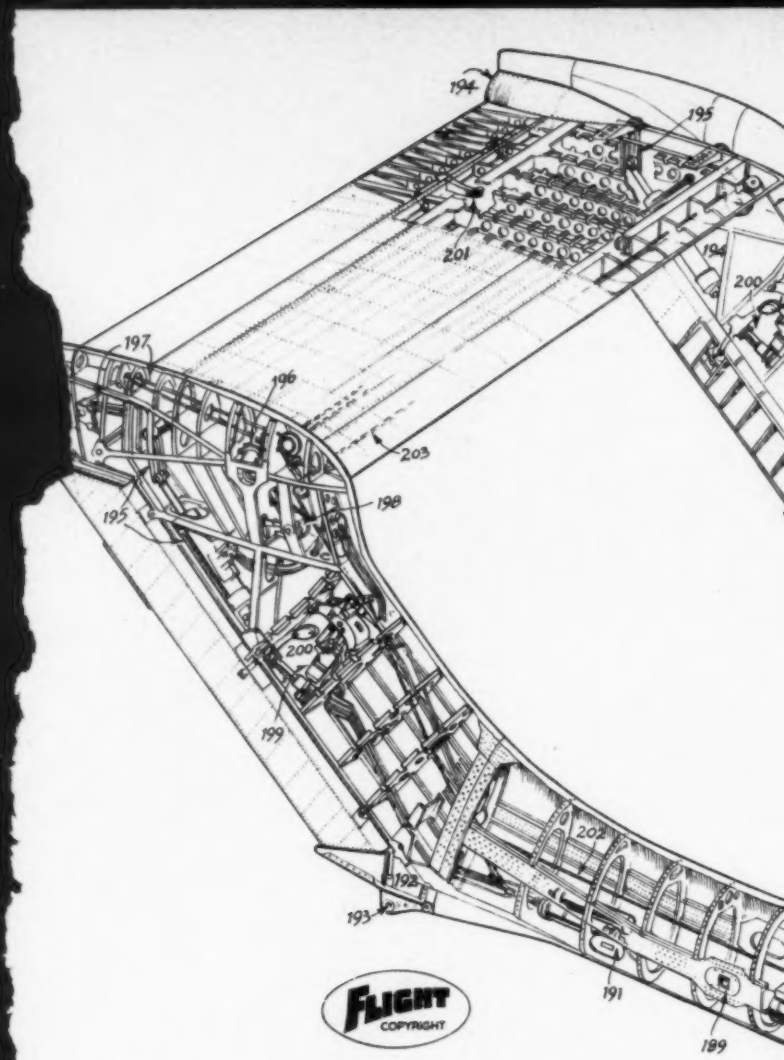
obe/drogue method. In addition, a hose- arried in place of the starboard drop tank to a tanker. All tanks, including those e filled through the probe very quickly, ce both by day and night.

bled from the final stages of the engine pressurizing and conditioning the cockpit suits, canopy demisting and windscreen heating the guided weapons, and for rators.

ned air supply, air bled from the engines through a ram-air heat exchanger and a into a water separator, and part flowing pass valve. The amount of air by-passing ted thermostatically from the temperature The conditioned air is then ducted into irected over the canopy and windscreen d at the pilot's and navigator's head and o cool some of the radar and equipment sure bulkhead before exhausting through other bleed direct from the engines is ylons for heating the guided weapons, controlled by two leading-edge heat

the wing roots is pumped by the fan on the engine-compressor zones. Tappings ovide for cooling portions of the weapon For cooling the Firestreaks after they are is drawn from 3,000lb/sq in bottles, hood and canopy seals. The engines are ir.

eed of sound. Nevertheless, a long period of roduction aircraft being those of 892 Sqn RN
"Flight" photograph



FLIGHT
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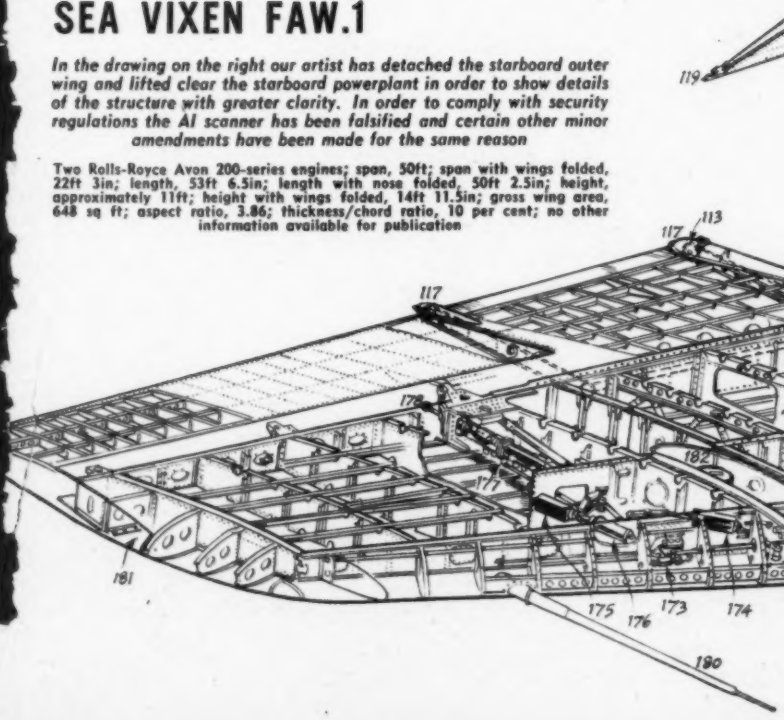
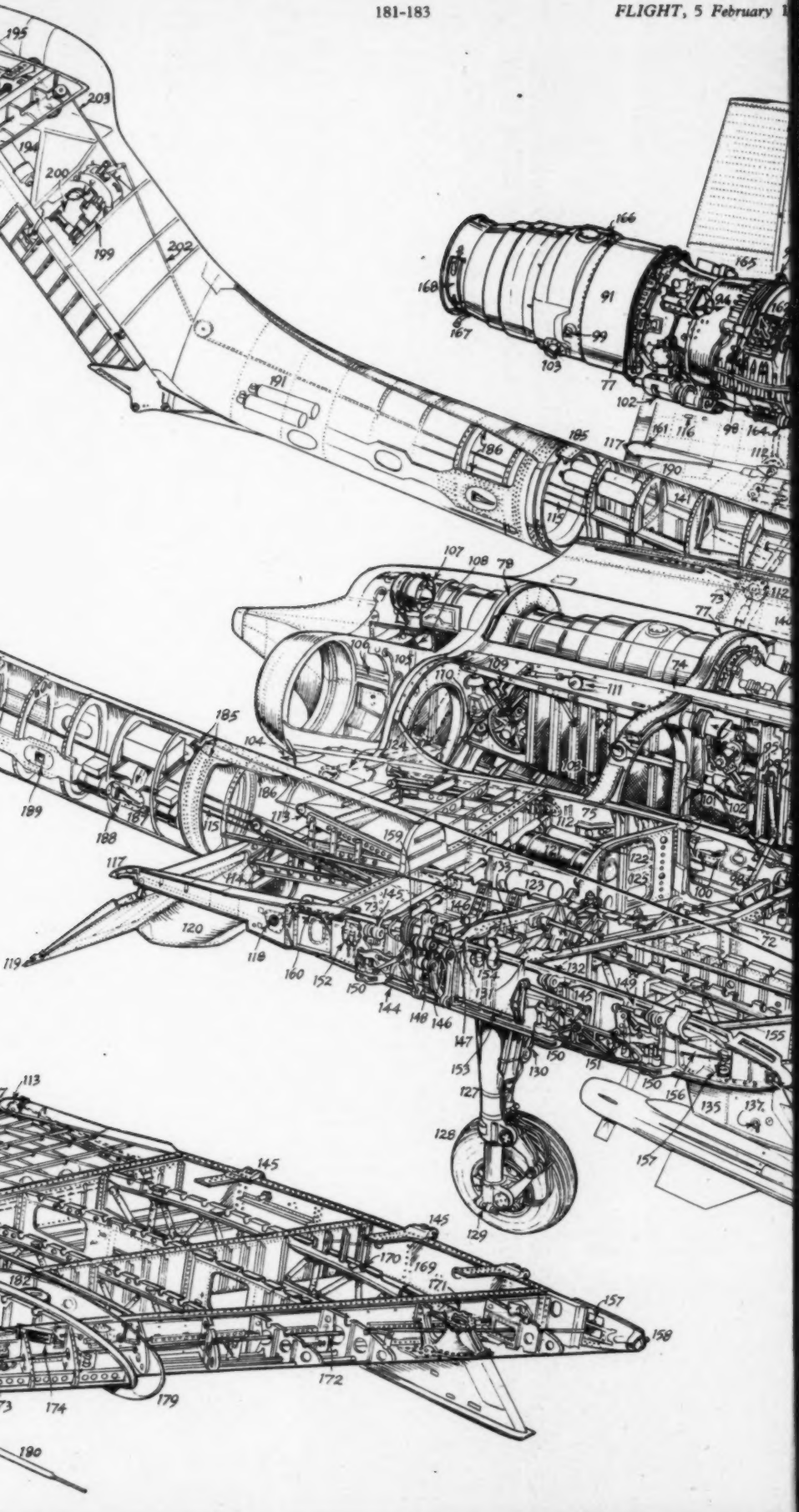
A. BOWDLER

SEA VIXEN FAW.1

In the drawing on the right our artist has detached the starboard outer wing and lifted clear the starboard powerplant in order to show details of the structure with greater clarity. In order to comply with security regulations the AI scanner has been falsified and certain other minor amendments have been made for the same reason

Two Rolls-Royce Avon 200-series engines; span, 50ft; span with wings folded, 22ft 3in; length, 53ft 6.5in; length with nose folded, 50ft 2.5in; height, approximately 11ft; height with wings folded, 14ft 11.5in; gross wing area, 648 sq ft; aspect ratio, 3.86; thickness/chord ratio, 10 per cent; no other information available for publication

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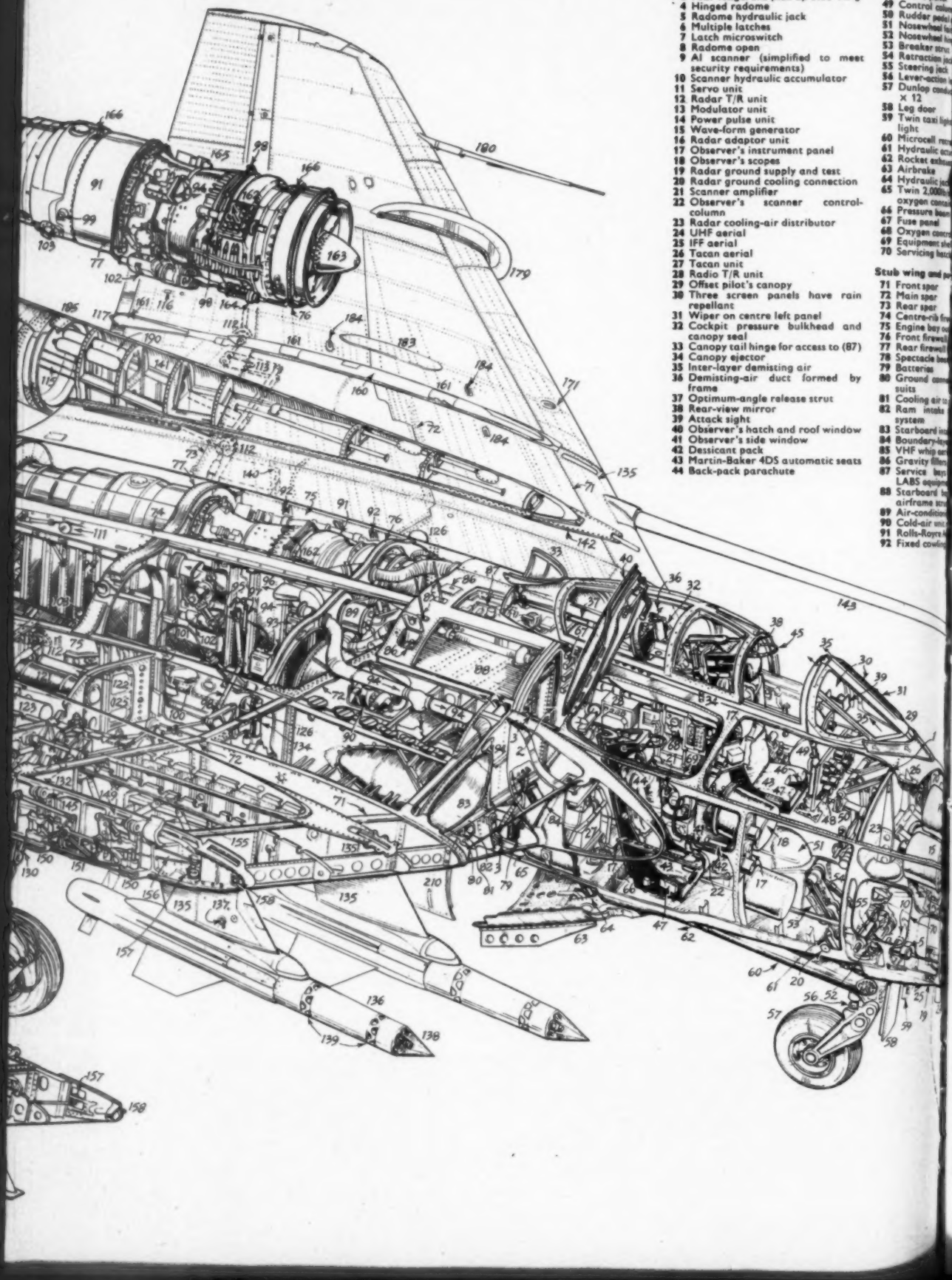


Forward Fuselage

1 Front pressure bulkhead
2 Rear pressure bulkhead
3 Four longerons pick up stub wing
4 Hinged radome
5 Radome hydraulic jack
6 Multiple latches
7 Latch microswitch
8 Radome open
9 AI scanner (simplified to meet security requirements)
10 Scanner hydraulic accumulator
11 Servo unit
12 Radar T/R unit
13 Modulator unit
14 Power pulse unit
15 Wave-form generator
16 Radar adaptor unit
17 Observer's instrument panel
18 Observer's scopes
19 Radar ground supply and test
20 Radar ground cooling connection
21 Scanner amplifier
22 Observer's scanner control-column
23 Radar cooling-air distributor
24 UHF aerial
25 IFF aerial
26 Tacan aerial
27 Tacan unit
28 Radio T/R unit
29 Offset pilot's canopy
30 Three screen panels have rain repellant
31 Wiper on centre left panel
32 Cockpit pressure bulkhead and canopy seal
33 Canopy tail hinge for access to (87)
34 Canopy ejector
35 Inter-layer demisting air
36 Demisting-air duct formed by frame
37 Optimum-angle release strut
38 Rear-view mirror
39 Attack sight
40 Observer's hatch and roof window
41 Observer's side window
42 Dessicant pack
43 Martin-Baker 4DS automatic seats
44 Back-pack parachute
45 Seat firing h
46 Alternative f
47 Personal-ser
48 Pilot's panel
49 Control colu
50 Rudder pedal
51 Nosewheel s
52 Nosewheel st
53 Breaker strut
54 Retraction jac
55 Steering jack
56 Lever-action
57 Dunlop cond
× 12
58 Leg door
59 Twin taxi ligh
light
60 Microcell rec
61 Hydraulic act
62 Rocket exhau
63 Airbrake
64 Hydraulic jac
65 Twin 2,000-l
oxygen conta
66 Pressure bea
67 Fuse panel
68 Oxygen conc
69 Equipment sh
70 Servicing hatc

Stub wing and p

71 Front spar
72 Main spar
73 Rear spar
74 Centre-rib fra
75 Engine bay o
76 Front firewall
77 Rear firewall
78 Spectacle bea
79 Batteries
80 Ground conne
suits
81 Cooling air to
82 Ram intake
system
83 Starboard int
84 Boundary-lay
85 VHF whip ant
86 Gravity filler
87 Service bays
LABS equipm
88 Starboard ha
airframe str
89 Air-conditio
90 Cold-air unit
91 Rolls-Royce
92 Fixed cowlin

BOAC's Boeing 707s are all to be modified prior to delivery from Seattle. Basil Smallpeice, managing director of BOAC, commented that "We trust it will not cause a serious delay"

AIR COMMERCE

BOAC, Boeing and the Board

WHILE Boeing still claim on-the-nail or early delivery for every 707 so far, by the time BOAC's first -420 reaches London this claim will no longer be valid. It came as something of a shock, although not as a complete surprise, that following flight tests by E. P. Davies, the Air Registration Board's chief test pilot, British approval of the 707 was still withheld. The issues are quite separate from those affecting take-off performance (*Flight*, December 25).

Unease at the aircraft's behaviour is apparently concerned with the three training incidents which occurred last year, two of which resulted in fatal accidents. In each case, it was lateral behaviour of the aircraft at slow speeds that was called to question, although it is believed that the initiating actions were quite different in each case. The two incidents in which engines were shed—over France in February and Seattle in September—were apparently the result of demonstrations, possibly inadvertent, of conditions outside the normal flight envelope. On the other hand the American Airlines' accident over Long Island in August during a two-engine approach in a gusty crosswind could not be explained in this way, although again it was suggested that had a different technique been adopted the accident might have been averted.

From the violent rolling manœuvre that developed on each occasion it may be inferred that roll and yaw control demands higher-than-average pilot skill under asymmetric thrust, at low speeds, and in adverse conditions—a conclusion that is borne out by Boeing's intention to increase the -420's fin height by a drastic 35in, to add a small ventral fin and to provide full rudder boost on the Boeing 707-120. (The -320 and -420 rudder is already power-boosted beyond 15° travel to counter additional engine thrust, and the Qantas -138s were modified similarly before delivery.) Another 707 modification apparently found desirable is duplication of the yaw damper, and this again points to Boeing's persuasion that low-speed flight is a regime where control could be improved. It should be made clear that although the -420s are to be modified at ARB's behest, Boeing have conducted on their own account a similar programme with other aircraft in the 707 series. The first modified 707-420 will be ready for trials in the early part of this month and it will again be flown by Mr Davies before it is finally accepted and handed over to BOAC.

But while it now seems probable that all future 707s may be modified as part of normal design improvement, it is not clear if retrospective action is contemplated, nor who would pay for it if it was. All deliveries made so far have been under FAA certification or validation, and unless this certification standard is changed (and there is ample precedent for this in the past history of 707 approval) it would at first sight seem to be incumbent upon airline customers to request and pay for modification action themselves.

What is involved is a matter of opinion about pilot skill, and perhaps this makes the modifications under discussion different from mere design improvements. As a matter of policy Boeing may thus take responsibility for the modification upon themselves.

After the accident at Long Island last year it was questioned whether, with the lessened likelihood of a pilot experiencing full asymmetric turbojet failures, a training demonstration of this kind should now be needed. And the FAA demanded that this type of exercise, tacitly admitted to be a difficult condition with a swept-wing aeroplane, should be attempted only at altitude.

The ARB's insistence on modification suggests a philosophy that if a redeemable failure case exists, it must be demonstrated, and pilots must be trained to handle it. Indeed, looking back on the FAA's "high altitude only" rule, it is easy to argue now that this could only have been thought of as an interim measure and that the FAA too must be concerned that low-speed asymmetric control must be improved until it is no longer a hazard.

Looking at the particular modifications a little more closely, the fin extension (and rudder boost in the case of the -120) are obvious ways of improving asymmetric-thrust control at low speeds. This is adversely affected by sideslip or yaw of the swept wings, because rudder tab effectiveness is reduced. Another gain will accrue from the ventral fin. It has incidentally been suggested that this fin could act as a tail bumper and so reduce any penalties that may result from an excessively nose-high ground angle. The full take-off story has yet to be told, but it now seems to have been successfully demonstrated that the geometry of the 707-420 is such that ground stall does not occur and that only revision of the flight manual requires to be completed.

BOAC's TOP PEOPLE

FOLLOWING the *Daily Mail's* forecast of "A Big BOAC Re-Shuffle" (see *Flight*, January 22) came a report in the *Daily Telegraph* repeating that the chairman, Sir Gerard d'Erlanger, and the deputy chairman, Sir George Cribbett, would resign. The newspaper added that Eric Rylands of Skyways was to be given Sir George Cribbett's primary responsibility of chairmanship of BOAC Associated Companies Ltd.

At first none of these reports could be confirmed in the appropriate quarters. Then on January 31 the Minister of Aviation, Duncan Sandys (who was in South America with Sir Gerard), issued the following statement:—

"In view of speculation that has arisen about the membership of the board of BOAC I should like to make the position clear. Last November Sir Gerard d'Erlanger told me that on account of demands of his private business he would not wish to continue as chairman of BOAC after expiry of his current term of appointment in 1961.

"A day or two before my departure for South America the deputy chairman, Sir George Cribbett, informed me that for reasons of health he would not be able to continue for more than another three months. I therefore must reluctantly accept this resignation with effect from April 30.

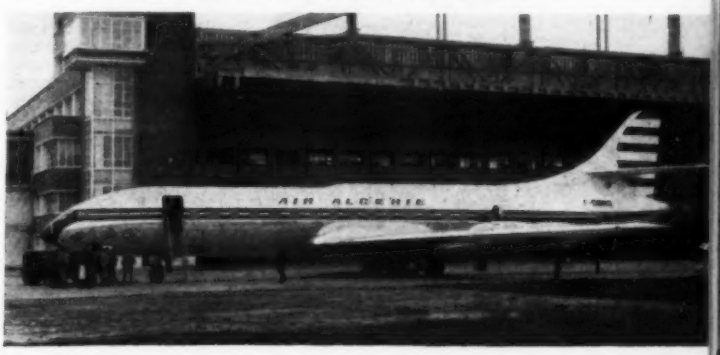
"I have not as yet taken any decisions about future appointments."

THE ELUSIVE ALL-FREIGHTER

THREE sets of specifications for the Lockheed GL-207 Super Hercules and the swing-tail Canadair CL-44D have failed to meet the requirements of American Airlines, according to William Littlewood, vice-president equipment research, in route-case evidence before the CAB. American, he said, were studying proposals for both turboprop and jet all-cargo aircraft in an attempt to meet their requirement for aircraft in the 40,000-60,000lb and 80,000-100,000lb payload capacity class for intermediate and long haul service. He specified a d.o.c. of between 4c and 5c per c.t-m.

Both Lockheed and Canadair were, he said, refining and improving their specifications. Earlier he had told the CAB that an improved version of the Super Hercules, the GL-207-23, with a gross weight of 200,000lb and a maximum payload of 77,400lb was "penalized by the length requirement for landing." This was said to be 8,350ft. The aft-fan versions of both the Boeing 707 and the DC-8 were being examined by American: he gave the payload of the 315,000lb Boeing 735 as 93,766lb. There are two versions of the Model 735—the -28, priced at about $6,825,000, and the 735-30 with higher weight and increased thrust priced at about $8,025,000. In addition to American Airlines, Slick Airways is also reported to be interested in the Boeing 735.

Pictured outside the Sud factory and control tower at Toulouse is the first Caravelle for Air Algerie, delivery of which was accepted early last month. It has been in service for nearly five weeks



Air start carts: That on the left is the Atlas Copco Air Partner drawn up preparatory to starting the engines (or air conditioning the fuselage or de-icing) of a Sabena 707. On the right, in front of a Boeing 720, is a new model of the Turbo-Starter developed by Boeing Industrial Products and by GEC. In addition to the pneumatic supply, a 60kVA alternator supplies ground electric power

AIR COMMERCE . . .

DC-8 "AS FAST AS THE 707"

COMMENTING on reports that the Boeing 707 is faster than the Douglas DC-8 (see Straight and Level, page 175), J. A. Herlihy, senior vice-president engineering of United Air Lines, says that "a check of point to point flight times of all major transcontinental airlines shows that the speed of United's DC-8s was the same as that of the Boeing 707." Actual figures for the six-week period ending December 26, covering 200 parallel flights, show that the time difference between the 707 and the DC-8 equipped with the same engine [JT3C-6] has been "negligible." It has averaged two minutes for California - New York flights.

Mr Herlihy, speaking recently before the Yale Engineering Association of New York City, warned that people must not expect too much from the turbofan engine as an aid in noise abatement: while exhaust noise was improved, compressor noise might be aggravated. He also warned against "a facile optimism" about the development of supersonic airliners. "My opinion is that it will be at least the early 1970s before such an operation is feasible." With an investment of more than $1,500m in subsonic jets the airlines, he said, were "most reluctant" to begin any early large-scale planning for supersonic flight. United had estimated that the development cost of Mach 3 transports could well reach $1,000m compared with $300m for the DC-8.

The difference between this airline viewpoint on supersonics and that of the aircraft salesman is neatly highlighted by a recent statement attributed to J. R. McGowen, vice-president commercial of Douglas. He foresees the advent of supersonic transports by "about 1970," cruising at Mach 3. He added, according to a Douglas news release, that it was conceivable that this step would be eliminated "in favour of rocket power and speeds of about Mach 10 by about the same time." (See "Supersonics At The IAS," col. 2.)

To add to the confusion, another United official, Robert E. Johnson, senior vice-president sales, apparently disagrees with his colleague Mr Herlihy about supersonic timing. He says a supersonic transport will replace the subsonic jet transports "but not until late in the 1960s." This, he said, would make it possible for the airlines to amortize their $2,000m investment in subsonic jets over a useful life of at least ten years.

AIR LATIN AMERICA

A TENTATIVE second step towards the formation of a consortium of Latin American airlines was taken last month when the airlines of five nations decided to hold a second meeting. The first, at which Peru, Chile, Venezuela, Panama, Ecuador and Colombia participated, was held last autumn in Panama City; the second, to take place in Santiago this month, will be attended by airline representatives of Peru, Chile, Panama, Bolivia and Ecuador.

As yet it is not clear which airlines are the pace setters, although the carriers principally involved are believed to be AVIANCA (Colombia), LAN (Chile), Compania Ecuatoriana de Aviacion (Ecuador), Aerolineas Peruanas APSA (Peru) and Compania de Aviacion "Faucett" (Peru). Of these five, LAN is the only IATA member and its intentions within a union of carriers who otherwise operate at sub-IATA fares on inter-America services must be a matter for speculation; the union would presumably not participate in the Association, if only to remain untrammelled by IATA fare rates.

The inter-Americas fares and traffic picture, writes a correspondent, is undoubtedly chaotic. Each and every airline operating through Brazil will be allowed to carry only 10 per cent more passengers than it carried in 1959, and only should exceptional circumstances favour it will another 10 per cent be authorized by the Ministry. The Argentine Government would also like to take some definite action but Argentina's position as a creditor country no doubt discourages it from adopting unpopular attitudes towards air travel. "On services to North America in 1959 there were 1,000,000 seats chasing 460,000 passengers and the increase in passengers this year will in no way serve to fill all the new seats available. The conclusion is gloomy but inescapable; the ratio of seats available to seats booked worsens steadily instead of improving."

However trenchant the economic issues and problems of national sovereignty may appear to the South American airlines, those of replacement of heterogeneous equipment may fairly be assumed to transcend all others. Certainly the announcement of this second meeting brought a noticeable quickening of interest in this previously difficult market by British and American jet and turboprop manufacturers. If nations as diverse in temperament and persuasion as France, Germany, Belgium and Italy can combine to form an economic and equipment union, the argument seems to run, are prospects for Latin Americans not at least as hopeful?

ROYALTY BLAMES PANAM

PRINCE BERNHARD of the Netherlands told a press conference at Schiphol on January 26 that he considered Pan American the main stumbling block in KLM's negotiations in Washington to obtain west coast traffic rights (see *Flight*, January 22).

The Prince said: "It would be unprecedented if landing rights were again refused under the pressure of one single company. It is only PanAm that resists, and it does so because it fears its Dutch rival. In aviation it is a very unusual situation that one cannot go to every port that one desires to load and unload passengers and cargo, as in shipping. It is just that airlines are afraid of KLM. That is because of its excellent service. I do not know whether you have had the bad luck but I have travelled enough with American companies to know what the difference in service means. . . ."

Prince Bernhard added that the Netherlands were a good ally of the USA, and economic relations with California were very firm, especially in aviation. Many other airlines had obtained landing rights in California, and he could not imagine "that any American, judging objectively, would place KLM in an exceptional position."

SUPERSONICS AT THE IAS

A SUPERSONIC airliner in the Mach 2-3 range could be in service in 1965 and with operating costs of less than 3d per seat mile. This is the considered view of North American Aviation in a paper read before the second annual "supersonic symposium" of the US Institute of Aeronautical Sciences in New York last week. We hope to summarize this and other papers in an early issue.

North American are developing the B-70 Mach 3 bomber, and their absence from last year's symposium was the subject of much comment. They have now shown their hand, and their studies favour a delta-wing canard arrangement with buried re-heat turbojets. A first flight in 1963 was feasible, North American having already performed no less than 14,000 hours of tunnel testing on

a number of different civil or military Mach 3 configurations.

A Lockheed paper read before the meeting recalled that over a year ago the company had said that a supersonic transport could be available as early as 1965, though this date had, in the absence of any go-ahead, slipped somewhat. In their view a 250,000lb steel Mach 3 transport might cost more than £57m to develop, whilst a 500,000lb aeroplane could run as high as £75m. The initial cost of a Mach 3 250,000lb transport would be about £4m, and 500,000lb transports about £7m each. In the supersonic transport the US had an opportunity to demonstrate to the world its technological leadership over the Soviet Union. In their opinion the Government would be justified in supporting it simply for national prestige reasons, not to mention all the others. The Lockheed paper added that the US could move into production if the airlines of America would pool resources, and it was possible too that one, two or more manufacturers could combine forces to develop the aircraft.

SOUTH AMERICAN ROUND TABLE

IT was to be expected that the personal presence of the Minister of Aviation on the inaugural BOAC Comet flight to South America would be available to smooth the airline's political passage. And less than a week after his arrival he was already delayed in Buenos Aires for discussions with the Argentine Government. Argentine restriction on sector traffic carried by foreign carriers between Argentina, Chile, Uruguay and Brazil was imposed a year ago and as BOAC were not then operating it could mean that the corporation are legally not permitted to uplift any South American sector traffic at all. Since this was a unilateral decree, Mr Sandys takes the view that the recently renewed Anglo-Argentine air services agreement of 1946 still stands.

Another country with which the minister will be holding discussions is Brazil, whose Ministry of Aeronautics has recently established quotas for all the carriers on the South Atlantic route. BOAC's Fifth Freedom rights are threatened with reduction to one service a week. While this is claimed to have been done to prevent a repetition of the tariff war, it has also been suggested that these restrictions are designed to protect the national carrier, Panair do Brasil.

Another matter under discussion is the pool agreement between Aerolineas Argentinas and BOAC on which, says Sir Gerard d'Erlanger, discussions started two years ago. The Argentine carrier apparently wishes to exclude the stages within South America and to restrict the arrangement to South Atlantic traffic from London only.

S-61 v. VERTOL 107

LIKE BEA's, New York Airways' choice of a 25-passenger twin-turbine helicopter lay between the Vertol 107 (T-58) and the Sikorsky S-61 (T-58). The two other leading US helicopter carriers had already decided upon the S-61: Los Angeles Airways placed an order for five last October and Chicago Helicopter Airways ordered three of the triple T-58-6 version last June. Now the Vertol 107 has been chosen by NYA.

NYA will introduce the first five of their order for ten into service in the spring of 1961, and all ten will be in operation by the end of 1963. By this time, if all goes well, New York Airways will be firmly committed to their provisional order for five Fairey Rotodynes.

One of the factors influencing NYA in the choice of the Vertol was the "ability of NYA and Vertol engineers to devise a baggage compartment that will greatly facilitate cargo handling and thus cut down ground time." Meanwhile it remains to be seen which of the two American helicopters is chosen by BEA.

The president of NYA, Robert Cummings, is due to read a paper on his airline's helicopter operations today, February 5, before the RAeS Rotorcraft Section at 4 Hamilton Place, W1.

LAST OF BOAC'S ARGONAUTS

NINETEEN of BOAC's 20 Canadair DC-4M Argonauts, introduced into service in August 1949, have now been sold. The last four have been bought by Overseas Aviation (Channel Islands) Ltd, who already own five.

The original BOAC fleet of 20 Argonauts has been disposed of as follows: EAA, 3; Overseas, 9; RRAF, 4; Aden Airways, 3. The remaining one is used by BOAC apprentices for practical training. The value of Argonaut sales has not been quoted by BOAC. The corporation have also announced recently that their two DH Doves have been sold to a private buyer; they were used for airborne classroom training.

Footnote: Overseas Aviation (C. I.) Ltd are understood to have been studying the possibility of purchasing two of BOAC's DC-7Cs.

BREVITIES

The important "try-again" IATA traffic conference on fares is to be held in Paris from Tuesday, February 23. The chairman will be V. H. L. Dubourcq, vice-president of KLM.

Spokesmen for Airwork and Hunting-Clan could make no comment last week on a *Daily Express* report that talks about a merger of the two groups were "nearing settlement."

The projected development of the VC10, the "Super VC10" with a fuselage stretched by 30ft and with accommodation for up to 200 passengers, is likely to be ordered by BOAC, according to a report in last Tuesday's *Times*. The corporation may buy ten, in addition to its existing order for 35 VC10s, for transatlantic operation from 1965.

Royal Air Maroc has exercised its option on a second Caravelle, bringing the total of firm orders to 61.

Air France operated its first scheduled Boeing 707 service on the Paris to New York route on January 31.

Price of the Bréguet 941 (four D.H. Gnomes), according to American reports, is tentatively put at about £250,000, with 40-48 seats.

Two Electras have been bought by Transamerican Aeronautical Corporation who have plans to lease the aircraft. The order brings to 172 the number of Electras sold to 19 customers.

The Scottish manager of BEA has announced that the corporation will increase summer services on the London - Edinburgh route by 50 per cent and London - Glasgow service by 30 per cent in 1960.

The board of Eagle Overseas Airways has been joined by F. A. Burden, MP. Eagle Overseas Airways was formed on December 11, 1957, to "fulfil the function of a development and study company for the group."

Lufthansa have now signed a contract for four Boeing 720B (JT3D turbofans) and have placed an order for a fifth 707-420 (Conways). As previously reported, Air-India have ordered another 707-420—their fourth—and sales of all 707 variants now amount to 204 of which 90 have been delivered.

The 47th market report issued by Aircraft Exchange includes an offer to lease a Britannia 318 at $65,000 (about £23,000) per month. The Britannia 318 is the version supplied to Cubana, who own a fleet of four. Northwest have become the 100th member of the Exchange.

A joint Turkish-Scandinavian inquiry into the SAS Caravelle disaster near Ankara on January 19, causing the loss of 42 lives, states that the aircraft was flying too low, but for a reason as yet unknown. The investigation has ascertained that there was no mid-air explosion, and that no blame could be put on the Turkish ground staff, nor had there been any failure of airport equipment or communications.

A party of BEA directors and executives, including the chief executive Anthony Milward, flew in the Dart Herald from Northolt on January 28.

Douglas announce that the JT4 version of the DC-8 has been certificated by the FAA. Deliveries are now being made to Eastern, United and National.

Load factor achieved in December 1959 by the 12 US domestic trunk carriers was 58.4 compared with 66.9 in December 1958 when jet capacity was in short supply.

The de Havilland Heron which was missing on January 27 on a flight from Darwin to Portuguese Timor was CR-TAI, operated by Transportes Aereos de Timor. There were seven passengers and a crew of two on board.

Sabena are negotiating with Air France for the lease of three Caravelle 3s during the winter of 1960-61 for their European and Middle East routes. Delivery of the first of Sabena's four Caravelle 6s will be made in February 1961.

Of the 11 American Airlines' DC-7Bs being converted to DC-7Fs by Douglas, six have been delivered. The first went into operation last October. The first of six DC-7Fs being converted by Douglas for United will be put into service in March.

The latest move towards solving the jet noise problem at Los Angeles International is to move the threshold of the main instrument runway some 600ft farther west. This will call for new approach lighting at a cost of about £12,500. It means, in effect, a reduction in runway length.

The FAA has issued an airworthiness directive calling for inspections for daily and 125hr inspections for cracks near the outboard elevator hinges on all Fairchild F-27s. Cracks found on nine aircraft have been dealt with by a Fairchild repair programme. If cracks are discovered the aircraft must not fly until they have been repaired.

The chairman of BWIA, H. O. B. Wooding, has been in the US visiting Boeing, Lockheed, Douglas and Convair. American reports say that BWIA wants jets for operation to New York and London by mid 1961. This is the first public indication that this BOAC associate, which has hitherto had its aircraft bought for it by BOAC, is shopping for its own equipment.

As from March 6 Qantas will increase jet services on the Pacific to five per week. This will give Qantas five jet services a week each way on the Pacific and three each way on the Kangaroo Route through India to London "carrying at least 90 passengers at a time," says the chief executive, C. O. Turner. "This 707 pattern will enable Qantas to fly almost 6,000 passengers each month into and out of Australia." A further 2,400 seats per month will be added by BOAC's Comet 4s.

MEMO TO MR SANDYS

—With Special Reference to the New Air Transport Board

By J. M. RAMSDEN

Duncan Sandys, Minister of Aviation, lending his ear to advice—some more of which is offered in these pages

QUITE soon now Duncan Sandys, Minister of Aviation, is to lay before Parliament new legislation which will profoundly influence the future of the British air transport industry. Upon the future prosperity of this industry—the State corporations and the independents—depends as never before the future of British aviation as a whole. So it is as well to clear our minds on the issues before us. Let us put them down in the form of a memorandum to the Minister.

You will, sir, being a Minister of a Conservative Government returned with an increased majority, prescribe for private enterprise a bigger share of British air transport. You will no doubt sweep away the hypocrisy in section 24 of the 1949 Air Corporations Act which requires independents to operate scheduled services as "associates" of the corporations. This word has caused a good deal of friction in recent years, as all of us know. In many instances the corporations, though required by statute to sign associate agreements with the independents, regard their "associates" as competitors. Each corporation has said as much in its annual reports. Each has alleged material diversion of its business.

You said to Parliament on December 15 that it was not your intention "to do anything which will undermine BOAC or BEA, in which so much public money has been invested. They must continue to be Britain's principal flag carriers on the main air routes of the world. But there is scope also for the independents to expand." With this all reasonable people will agree.

But the corporations' monopoly of scheduled air services cannot be loosened without *at first* diverting some of their traffic: the cake is just so big, and there is no magical way in which you or any Minister can make one slice bigger without diminishing one or both of the other two slices. The aim must be to apportion the shares of British air transport in a way that will produce a larger cake. A fine suggestion, almost Ministerial in its overtones of wish fulfilment. But successful "mixed economy" air transport policies are achievable by skilful regulation, as Commonwealth and other countries have shown.

Australia's System

Australia has for seven years successfully mixed and regulated private and State air transport. In 1952, the same year in which the UK Minister of Transport and Civil Aviation, Alan Lennox-Boyd, prescribed his new deal for the charter companies, there was a crisis in Australia's air transport industry. This was caused by much the same sort of situation that confronts you: private operators, primarily ANA, were challenging the Government's right to maintain the State airline TAA's monopoly of Australia's domestic air transport. The upshot was the Agreement of 1952, whereby the Government provided ANA with the means to compete effectively with TAA—by Government guaranteed loans for the purchase of competitive equipment (two DC-6s and four DC-6Bs), and by giving ANA an equal share of the mail.

In 1957 this agreement had to be reviewed, following the purchase of ANA by Ansett; and this is what the Australian Prime Minister said in Parliament at that time (September 1957)—enlightened words that should have their echoes today in Westminster:

> "The policy adopted in the case of trunk route operations is [to provide] fair and equal conditions of competition for two major operators. The private airline concerned will be given continued access to Government mail and business, and assistance for re-equipment purposes. It will, however, be necessary to eliminate the wasteful effects of uneconomic competition on trunk routes by strengthening [regulation]. Under these conditions the Government believes that the trunk route operators should be able to make reasonable profits and yet provide at the same time the highly competitive type of service for which Australian airlines are noted."

Australia's mixed economy policy has worked well. The Government has had to step in only once—and that was to put a stop to "a struggle by each airline to out-equip the other, regardless of the capital cost involved." The resultant *Airlines Equipment Act* of 1958 was one of the most enlightened pieces of air transport legislation ever enacted by a Government: we mention it because (to quote the *Journal of Air Law and Commerce*) it reflected the Australian Government's "declared policy of maintaining competition between a Government instrument and a private airline and of ensuring that actions of the executive do not unfairly discriminate in favour of either airline."

We do not suggest that Australia's example is perfect. The State airline Qantas has, of course, always enjoyed the monopoly of international services. And Australia has no Air Transport Board to co-ordinate and regulate the nation's international and domestic air transport industry, which is something that we so badly need. But there are lessons that we can usefully learn from Australia's successful mixing of private and State air transport, and from the way it has disciplined the pace of re-equipment.

Canada too can teach the old country something. She has created a successful blend of private and public air transport, and she has an Air Transport Board which in many ways is a model of what we need. Until May 1959 there had been no direct competition between Canada's State airline TCA and the major independent carrier CPAL. Their spheres of influence in the *international* field had been—and still are—quite distinct. But last year, after long public hearings before the Air Transport Board, CPAL were permitted to compete directly with TCA on the transcontinental domestic route. It was Government policy, enunciated in 1957, to establish private competition for the State airline, since this would be (we quote George Hees, Transport Minister) "a valuable stimulus to more efficient operation, and to the provision of better service to the public." Competition would, however, be introduced "with caution and on a gradual basis."

Here again, closely paralleled in Canada, were some of the ingredients of the problems you now face. The Canadians had to ask themselves: Was competition from private enterprise likely to be a good thing? If so, how much competition? Stephen Wheatcroft's report—commissioned by the Canadian Government—was a classic analysis of these questions. We summarized it in *Flight* for August 22, 1958. Admittedly the issue was one of domestic competition. But already the Canadian private carrier concerned was handling 32 per cent of Canada's international air transport, a share of which it was granted in 1949.

What can we learn from Canada's Air Transport Board? This body has responsibility for regulating the competition between public and private air transport. It was formed in 1944, as an amendment to the 1919 Aeronautics Act, and it has a staff of about 25 executives in two branches under an Executive Director: (1) Director of Operations with divisions of traffic, licensing, inspection, and with a special Traffic Adviser; and (2) Secretary, with divisions of administration and special projects.

Canada's System

The Board advises the Minister on all air transport matters and is responsible for economic regulation "to help the industry along sound economic lines which will give fair returns to the operator and an adequate service to the public." No licences are issued to any operator who does not have an Operating Certificate from the Department of Transport. The issue of a licence is subject to Ministerial approval, and negative decisions may be the subject of appeal to the Minister. Regulations are made public as the Commercial Air Services Regulations and are amplified by directives, rules, circulars and so forth. All hearings are in public.

The structure of this Board is worth close study because under it Canada's air transport has prospered within the Government's declared policy of regulated public versus private air transport competition. In one respect, however, our Air Transport Board should differ: the issue of licences should not be subject to Ministerial approval, but should be the result of autonomous decision—though the right of appeal must be provided for.

Before we suggest the possible constitution of a UK Air Transport Board may we recall France's successful reconciliation of private and State airline interests? After years of bickering the Peira-Cava agreement of 1955 prescribed spheres of influence for the private (shipping-line backed) airlines TAI and UAT on carefully chosen overseas routes. The bickering goes on, largely as a result of complications brought about by Air France's participation in Air Union. But there are valuable lessons to be learnt, especially as French air transport, like ours, is having to adjust itself to the inevitable political independence of colonial African territories. One of the two private airlines, UAT, has been granted the right to develop the air transport industries of newly independent countries in French Africa (Mali, for example). It is the French Transport Ministry's belief that the state airline,

Air France, would inevitably be regarded as an imperialist instrument by the new nationalists, who want commercial ties with France, but no political strings. This enlightened approach to problems that resemble those you are facing is certainly worthy of your closest attention.

Perhaps your advisers have already made brainpicking investigations into the experience of the Australians, the Canadians and the French. If so, it was right for them to have done so, because the conflicts you are now trying to resolve—in a vacuum of State monopoly—have their parallels elsewhere. Of Britain's experience of mixed public and private enterprise in air transport it can fairly be said that we are a relatively backward nation.

What of America's experience? Your Ministry, in the course of many a wearisome contest, knows a good deal about the US Civil Aeronautics Board and its functions. It has been a patience-trying adversary on more than one occasion. It is a long-winded, quibbling and bureaucratic organization. But this should not cause your advisers to be prejudiced against some good points that we might usefully adapt to our own needs.

Most important is the CAB's power over IATA. The CAB cannot directly regulate international fares, as it does US domestic fares. But Section 412 of the US Civil Aeronautics Act empowers the CAB to demand from US carriers who are members of IATA all documents concerning rate-fixing proposals for review in advance of their discussion in IATA. The five-man Board, advised by its Bureau of Air Operations, then circulates the airlines with its opinions, which carry much weight in IATA. The US Government, through its appointed agent the CAB, is the only one in the world which does not just rubber-stamp IATA fare decisions. It should not be forgotten that it was the CAB who brought about the introduction of economy class fares in April 1958, by rejecting the airlines' arguments for a fare increase. Somewhere in Berkeley Square House may be a copy of the CAB's Order number E-11215, which provides a perfect example of how an expert government agency with a mind of its own can serve the public interest *and* the long term interest of the airlines. (Usually members of IATA consider only their own short-term interests.)

Reforms in the Act

Having learnt from the experience of others as much as we can (and we are surely not too proud or too complacent to do so) we must now consider what sort of executive air transport body will best suit our needs. What shall be its constitution, its powers, its terms of reference?

It is universally agreed that the time has come for reforms in the Civil Aviation Act, particularly in that section which provides for the regulation of British air transport. The Air Transport Advisory Council, conscientiously as its tiny secretariat and some of its members have interpreted their vague terms of reference, has been a pitifully inadequate instrument. No ATAC recommendation has ever been made on the basis of really thorough *independent* analysis of the issues involved. The arguments of one side are heard ("This proposed service will divert £6,253,121 of our business"), and then the arguments of the other ("the new service will generate entirely new traffic"), and so on. Then, all arguments having been heard, behind doors which are barred to the public, the Council has to make a decision that might profoundly influence the course of the industry.

Sometimes it turns to the Ministry for advice—notwithstanding the fact that its statutory function is to give advice to the Ministry. The system is no longer worthy of the industry. To this day, ten months after the ATAC's secret hearings, Parliament and the public have no idea what the Council's recommendations were on the independents' VLF (very-low-fare) Colonial coach service proposals. It was VLF more than anything else that emphasized the weakness of the system, because (as *Flight* remarked before the hearings, in our issue of March 13, 1959) "the Council needs backing up by a staff capable of analyzing these big issues scientifically."

For the ATAC must now be substituted a new *executive* authority, an Air Transport Board. It must be so constituted that it can be entrusted completely with the expansion, promotion and economic licensing and regulation of British air transport. Just as the ARB is the nation's brains trust in matters of airworthiness and design, so should the Air Transport Board be the repository of national knowledge and expertise in the commercial and economic aspects of air transport.

If constituted carefully it can be both master and servant of Britain's air transport industry. As master it would discipline the very fast rates of growth and technical development which can cause such instability. History has shown that while airline managements may be the best advocates of their own interests, their requirements are not necessarily in the best long-term interests of the industry as a whole. Examples are the gradual encroachment of BEA into BOAC's long-haul business; the wasteful duplication of many of the two corporations' technical and operational services; BOAC's recent policy of wanting to subsidize its proposed economy class services by the retention of tourist services, and—in some areas—the higher pricing of these services; BEA's complete elimination of competition by a 100 per cent pooling policy; the withholding by independents (BIATA and non-BIATA) of financial and traffic statistics without which a true picture of the industry is lacking; BEA's apparent loss of enthusiasm for the Vanguard, and the way in which both corporations have shrugged off the opportunity to create a demand for the cheapest as well as the fastest vehicles; and so forth.

The cry "We don't want a lot of civil servants telling us how to run our business" is very often justified. An airline's commercial judgement must be allowed full play. But there are matters which do require publicly calling to account; and the Air Transport Board (which we hope will be staffed by people as expert and dedicated as those in the ARB) would not be just "a bunch of civil servants." No one has ever said this of the ARB's people.

"Bunch of Tame Economists"

There is of course the chance that the Air Transport Board will come to be classed as "an interfering bunch of tame economists and lawyers." But this is up to the Board. And much depends upon the wisdom with which it is constituted. It is most important that the Board's terms of reference are such that all those indefinably precious "vague" qualities of British administration are preserved. We do not want a hidebound, legalistic and bureaucratic authority like the American CAB, which takes 20,000 pages of evidence (or was it 200,000?) on the airlines' case for a fare increase and then spends more than a year (so far) to decide its verdict, by which time many of the leading personalities involved have departed elsewhere. Nor, indeed, do we want to get embroiled in long-drawn-out hearings like those which took place before the Canadian Air Transport Board when the "CPAL versus TCA" domestic competition case was being considered. There is a great deal to be said for the goodwill and informality of the ATAC's methods, whereby the fewest possible people thrash out their problems under the shrewd no-humbug chairmanship of a man like Lord Terrington. These are characteristically British methods of settling issues: they have failed in the ATAC because (1) the Council has had no adequate secretariat to analyse independently the problems involved; (2) it has had no executive powers; and (3) it has conducted its business behind closed doors. There has been no public accountability—a matter to which we shall return in a moment.

The Air Transport Board will, we have no doubt, be responsible for licensing airlines to operate scheduled air services. It is most important that a clear distinction be drawn between an operating licence and a *route* licence.

In all the recent talk about the need for a "new licensing authority" this distinction has never been drawn. It is quite clear in our minds: every operator should, on safety grounds, be required to possess an operating licence (let's call it, as the Canadians do, an operating certificate). This would be issued—like personnel and aircraft licences—by your Ministry. Just as pilots and engineers and aircraft have to be properly licensed by the Government before they can operate, airlines that wish to operate air services (though not necessarily *ad hoc* charters) should henceforth be similarly licensed. Will this require a huge staff of enforcement officers? Probably not, because every operator would know (like every pilot) that negligence could mean the loss of his licence and hence his livelihood.

Deterrent Already Exists

In effect, of course, such a deterrent is in force today in a non-statutory (though nonetheless effective) sort of way, as two independents in 1958 discovered to their cost. An operating certificate would make *de jure* your *de facto* powers of making life impossible for "sharp operators": it is no more significant than that.

But it need not be administered by the Air Transport Board. It is the *route* licence (which of course would be granted only to holders of an operating certificate) that should be at the disposition of the Air Transport Board. Such a licence would be granted on economic and public interest grounds after proper hearings and independent analysis of the issues involved. When we talk of the Air Transport Board as a licensing authority, we mean route licensing. The issue of route licences will be the primary end-product of the Air Transport Board, which will bestow upon the most suitable applicant a licence to operate scheduled services after full public hearings and its own assessment of the implications.

There will be no precipitate handing-over of routes to independents, none of whom has the *savoir faire* to do the job BOAC and BEA are doing. But the corporations' monopoly of almost every British domestic and international air route will no longer be inviolate: independent pressures to break this monopoly will no longer be frustratingly stranged at birth, and their proposals and arguments for a share in route A or route B will have the

The new Minister of Aviation has made a point of seeing as well as listening. Here he is in a BOAC Comet 4 with Charles Abell, the corporation's chief engineer, and Sir Gerard d'Erlanger, chairman

MEMO TO MR SANDYS . . .

effect of keeping the established carriers on their toes by requiring them to justify their efforts.

But the corporations do not have much to fear from any legislation that you might introduce to loosen their monopoly. The existence of this monopoly has encouraged big talk from the independents; but will they talk so big when faced with the realities of big-league international air transport? Will they be prepared, like BOAC and BEA, to take the rough with the smooth (forgive the phrase), to take on their share of the thin routes as well as the fat ones? The Air Transport Board will turn a deaf ear to applications for cream-skimming services only. And will the independents' low costs really be so much lower than those of the corporations when expensive new equipment has to be bought, when sophisticated overseas sales organizations and maintenance facilities have to be established? Similarly, no change in an Act of Parliament will alter the fact of IATA, nor will it substantially alter the political nature of international air transport whereby every international service must conform to the terms of a bilateral treaty between the countries concerned. Here the corporations hold a monopoly which no Act of Parliament can vary.

On the whole, the corporations do not have a great deal to fear from the removal of those sections of the Act which protect them from "material diversion" by independents' operations. And even if an independent were prepared to challenge the universe, there would still be an Air Transport Board to be convinced of its case.

There will be modest adjustments at first, and perhaps for a long time to come. VLF is a typical example of independent initiative that ought to be given a fair trial, for the reasons suggested in *Flight's* recent reviews of the subject; and the new Board will have powers to decide whether such a trial is merited. Again, an independent might be granted the right to compete with BEA on London - Manchester or London - Belfast domestic routes, provided that after a reasonable period it was prepared to relieve BEA of some of its marginal domestic routes. These are the sort of issues the Air Transport Board will have to decide. But we feel sure that the removal of the corporations' monopoly will evoke from the independents much the same disenchantment that prompted the famous cry: "They have shot our fox!" There will be a lot less huffing and puffing against restrictionism and corporation failings when the long-closed door is opened.

Not The Ministry's Job

It has been suggested that you and your Ministry intend to make detailed recommendations on the way in which the air transport cake should be apportioned. We hope that you will agree that this should be the responsibility of the new Air Transport Board. This is the body that should reshape our air transport industry, not the Ministry. Create the Board, appoint to it the right men, give it autonomy, and then let it get on with the job. It must not be a toothless creature of the Ministry, working to rigid terms of reference and subject to the whims of whatever party is in power. The problems that it will have to solve are tremendous, and it cannot work to preconceived Ministry ideas about (for example) which independent should operate which route. There is a strong case for the appointment of a commission of inquiry into the big problems that the Board will have to solve. The guidance of such a commission would get the Board off to a good start in prescribing the optimum track for British air transport to fly.

What of the men whom you have to select for the Board? They should be few in number*, and non-partisan in their attitudes towards air transport. It would be a mistake to have a "representative" Board, i.e. two men from the corporations, two from the independents, one from the travel trade, etc. This does not mean that such sources should be excluded—only that selection should not conform to a rigidly "representative" pattern. We can think of no better chairman than Lord Terrington, whose diplomacy, knowledge of the law, and understanding of the essentials of the air transport industry are universally respected. Of his colleagues on the ATAC, J. J. Taylor has perhaps been the most able and respected. We would imagine that Stephen Wheatcroft, one of the country's most progressive air transport economist-philosophers, would have a part to play, either on the Board or within its secretariat. And there are substantial sections of the industry that would welcome to the Board Frank Beswick, the Labour ex-MP whose defeat at the election was a great loss to British air transport. If available, a man like Peter Masefield could bring the Board a rare blend of political, operating and technical air transport skills and experience. And Sir Toby Low's knowledge of air transport and his ability always to grasp the essential points of complex issues could serve the Board well.

We do not know whether any of these men are in fact available—we suggest them only because we believe they are of the right mettle. There are a lot of big names in British air transport, but the proposed Board has no place for the Establishment type of administrator whose "judgment" and "wide interests" and "flair for committee work" form no substitute for full-time, overalls-on, limelight-shunning devotion to a job he really knows something about. And we hope that provision will be made in the Civil Estimates for these men, whoever they are, to be well paid.

Composition of the Board's secretariat should provide for a permanent and highly qualified staff of traffic analysts, economists and accountants to advise the Board in its policy-making and licensing decisions. We believe too that the political side of international air transport—the negotiation of traffic rights—should be integrated into the Board and not remain in your Ministry. This is how the American and Canadian systems work. Liaison with the Foreign Office would still be close, but consultation would be biased more towards economics than politics—and any move to diminish nationalism in our air transport would be welcome. Let's have one body in which responsibility for *all* political, commercial and economic facets of Britain's air transport is vested.

Finally, we urge most strongly that the Air Transport Board shall conduct its hearings in open court. Not once in its ten-year history has the ATAC, as it has had the discretion to do, opened its court in Dean's Yard to the public or the Press. Big decisions affecting the public interest, and the interests of the publicly owned corporations, have been made on the basis of secret evidence. Naturally, there must be some evidence that it would be contrary to the public interest to disclose—but this could be a matter for the Board's discretion, as it is of a Court's.

The public administration of Britain's air transport industry is afflicted by a secrecy neurosis almost Kremlinesque in its intensity. *Flight*, for its own amusement and possibly one day for publication, has since last November kept a record of your new Ministry's replies to our air transport inquiries. No comment. Let the new Air Transport Board have full public accountability and let there be provision for a well-informed and helpful information department to tell the public and the Press about the good job which we feel sure the new institution of your creation will do for Britain's air transport industry.

SUMMARY

- The UK can profit from the Australian, Canadian and French experience of mixed public and private air transport.
- The new Air Transport Board should be an autonomous body responsible for the economic regulation of the industry and for the award of route licences.
- Issue of the quite different operators' certificates should be the function of the Ministry as an extension of its established responsibility for air safety.
- The Air Transport Board, and not the Ministry, should be charged with apportioning the shares of Britain's air-transport cake. An independent commission of inquiry could provide useful guidance.
- The Board should be HMG's agent responsible for approving IATA fares, and it should also have responsibility for Britain's international air agreements.
- The Board should be established as the nation's repository of knowledge and expertise in all commercial and economic aspects of British air transport. It will have in its care the public interest, in the widest sense of the term, and it should conduct its hearings in public.

**The Canadian ATB has four members, the American CAB five.*

FLIGHT SYSTEM SURVEY

Royston Instruments Midas

A COMPLETE system for the comprehensive routine recording and automatic processing of flight parameters is being proposed by Royston Instruments Ltd as an integrated flight recorder system for routine flying. The company has based its planning on the theory that it is possible to avoid the "factor of ignorance" in establishing aircraft maintenance schedules and thereby to save considerable time and expense. Broadly speaking, it is suggested that instead of defining overhaul life on the premise that each component undergoes maximum wear and strain during each flight, a recording system could be carried to detect exactly when the risk of failure arises. Components such as engines and undercarriages could then be left in service for a rather longer period without sacrificing safety.

A variety of installations of components of the Midas range has been developed together with a system of speeded-up automatic processing to translate the record into an edited, compact and usable form. Provision is made for ejection of the flight record in the event of an accident, the ejected unit being equipped with an inflatable float and a homing beacon to ensure recovery in the event of an accident over sea or in a remote area. It is stated that the flight record will indicate the exact cause of 99 per cent of all crashes.

Latest development in the Midas system of data recording on magnetic tape are the CMM400 series recorders which are light and robust, and whose tape cassettes can be inserted and removed by completely unskilled personnel. Maximum recording capacity is 160hr. The CMM400 units can be simply connected in parallel to the circuit of a variety of commercial transducers, frequency-modulated coding being employed to eliminate any tape imperfections.

Play-back and read-out equipment have also been designed by Royston, together with additional facilities to point out anomalies automatically. Parameters which may be recorded include engine and accessory characteristics, aerodynamic, pressurization, fuel and electrical system quantities, Doppler navigator indications and control-surface settings. A total of up to 300 such parameters may be recorded, together with a time code channel including date, flight number and aircraft number. A 1in-wide tape length measures 2,400ft and moves at 0.1in/sec. The basic recorder weighs about 40lb with loaded cassette. A complete technical handbook on Midas recording equipment is available on request.

Seacat Gyros in America

AN agreement has been concluded between Short Brothers and Harland and Giannini Controls Corp under which the American company is to produce the gyros used in the Seacat missile under licence. The agreement was arranged through Giannini's British subsidiary, Giannini Ltd, and Shorts will provide technical assistance over the next few years.

The Seacat gyros are accelerated to maximum speed at normal ambient temperatures in about one-tenth of a second by exhaust gases from a cordite charge within the gyro rotor escaping through tangential jets in its periphery. Of the two types of gyro, illustrated below, the free gyro has two degrees of freedom and is designed for roll stabilization. The gimbals are unlocked very soon after the rotor is speeded-up and the pick-off may be an a.c. transducer, a d.c. potentiometer or a commutator. The rate gyro for pitch and yaw rate of turn indication includes two wire-wound pick-off potentiometers, one for telemetry and one for output signals. Each gyro weighs only 7oz.

Centrally Patched Analogue Computer

As an extension to the well-known G-PAC range of real-time analogue computers Elliott-Automation have developed the G-PAC Mk 2 incorporating many improvements. The computer is manufactured by Panellit Ltd, a member of the Elliott-Automation group, and combines the convenience of a centrally patched computer with the flexibility of direct patching between units. Modular construction with plug-in brick units simplifies maintenance and allows the installation to be extended by the addition of further standard modules. The Mk 2 can be integrated with existing Mk 1s so that economic modernization can be achieved.

The central patched panel has removable problem boards which can be easily changed or stored and may also be set up away from the equipment. Power supplies and monitors are included with the basic components in the central element and output devices such as recorders, x-y plotters and CROs may be provided to special order.

Fixed-coil display consoles for a complete military operations room for a NATO air force being assembled in the West Molesey factory of Decca Radar Ltd. They are suitable for civil or military use and may present raw radar, either height or plan information or, in more complex systems, filtered information including marker symbols, track identities, call-signs and other factors. Production is at a high rate

Donner Jerkmeter

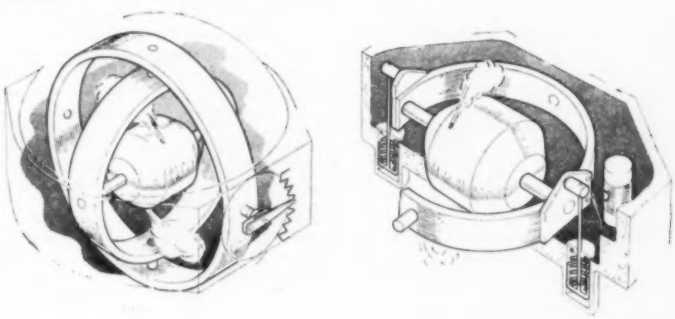
DETAILS have been released by Newmark (London) Distributors Ltd of the jerkmeter developed by Donner Scientific Co from their transistorized accelerometer. Louis Newmark Ltd are British agents for Donner accelerometers. The jerkmeter is accurate to 0.1 per cent and both this and angular jerkmeters provide output voltages which can be used to instigate compensatory control forces or other actions. An acceleration output voltage is also available.

The instrument may provide an instantaneous output proportional to the rate of change of g, such as might indicate impending disastrous failure, or a first-derivative term as a damping signal where constant acceleration is required, or a third order term for stabilizing displacement devices. It might also be used as an inertial indicator of first motion.

The jerkmeter operates as a sub-miniature servo system of the force-balance type and has an integrator inserted in the servo loop. Acceleration full ranges are between ± 1g and ± 30g and jerk full ranges between ± 0.5g/sec and ± 20g/sec, full-scale output being ± 7.5V d.c. in each case. The device weighs 3.5oz and measures 3in × 1½in × 1⅝in.

Collins in Middle East

IN March, the international division of Collins Radio Co is to open a Middle East and Africa office at Beirut to be headed by Charles Wallach, formerly FAA technical representative in the Lebanon. Areas covered will include Lebanon, Jordan, the UAR, Iran, Libya, Tunisia, Turkey and Cyprus, Syria, Pakistan, Aden, Saudi Arabia, Arabia/Kuwait and Africa with the exception of Morocco and Algeria. These areas were formerly covered by the Geneva office.



General arrangement of the two Short Brothers & Harland gyros for the Seacat which are to be produced under licence in the US by Giannini Controls Corp. At left is the two degree of freedom version and at right the damped rate gyro for roll or pitch axes. The gyro is accelerated to operating speed by peripheral jets from a cordite charge within the rotor

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. The names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

Interior Industry

IT was encouraging to see in *Flight* for January 22 that aircraft interiors are now considered of sufficient importance to warrant "special feature" treatment.

Undoubtedly there is now much closer co-operation between industrial designers, operators and manufacturers on the interior design of passenger aircraft; but the tendency in papers and magazines to glamorize the industrial designer without giving due credit to the manufacturer is disturbing.

With particular regard to the Comet 4, in order to correct any false impression it should be pointed out that the de Havilland Aircraft Co design office, in co-operation with BOAC, were responsible for the interior design and styling of this aircraft. The industrial designer's contribution to the styling was confined to furnishing materials and colour.

Stevenage, Herts — ARTHUR CARLTON SMITH

S.E.5 Armament

IN his description of discussions with a First World War pilot about S.E.5 armament (*Flight*, January 15) J. Andrews has demonstrated the unreliability of human memory as a source of historical fact. One hesitates to deny absolutely the existence of a British S.E.5 or 5a with twin Vickers guns, but it seems unlikely. Perhaps Mr Andrews' friend was confusing the armament of the S.E.5a with that of the Sopwith F.1 Camel.

The S.E.5as that Mr Andrews saw in *The Irene and Vernon Castle Story* were genuine enough, but that film was made during a period when on every wartime fighter appearing in American films two very obvious machine guns were *de rigueur*, regardless of authenticity. An example appears in the enclosed photograph [reproduced above—Ed.], which shows an S.E.5a used in *Hell's Angels*. It has two prominent guns of some kind in front of the cockpit but no Lewis gun.

The S.E.5a in the film "Hell's Angels"

In the course of fairly intensive research I have never found any reference to an S.E.5a with twin Vickers. However, it appears that B4885, built at the Royal Aircraft Factory late in September 1917, had twin Lewis guns in addition to the usual Vickers: the starboard Lewis was No 28743 and the port No 47202, but I have not been able to establish the nature of the mounting on which they were carried. In October 1917 another non-standard armament installation was made in B4875, also a Factory-built S.E.5a. Although originally completed with the standard Vickers and Lewis, this machine was fitted with the Eeman gun mounting, which carried three Lewis guns. All the guns were in the fuselage and pointed upwards at an angle of about 45°. A modified centre section was fitted: it had three slots through which the bullets passed. It would be interesting to know what happened to this S.E.5a and how its armament fared. It was still at Farnborough on January 10, 1918, when it had a new engine fitted; but its subsequent activities are unknown to me.

In a letter you published last year (October 23) Mr Bruce Robertson gave some interesting details of the modified armament on Captain Ball's S.E.5, A4850. Arising therefrom, Mr Lamberton of Shrewsbury has drawn my attention to an illustration in the book *Captain Ball, V.C.*, by Briscoe and Stannard. The original photograph, said to be the last taken of Ball, was poor; but it seems to show the Vickers gun mounted wholly outside and above the fuselage. The photographs of A4850 at London Colney indicate that it must have been fitted with a special main tank when the Vickers gun was first removed: the standard S.E. tank had a recessed portion to accommodate the barrel of the Vickers, but the tank on A4850 had no such recess. Perhaps Ball preferred to retain this larger tank, and had his Vickers replaced centrally on top of the fuselage. Can Mr Vousden or any other survivor of No 56 Sqn confirm or correct that theory?

A point that arises out of Mr E. Vousden's letter (also in *Flight* for October 23, 1959) is the fact that Ball's was not the only S.E.5 to have its greenhouse removed before No 56 Sqn went to France. Capt Henderson's aircraft, A4853, was similarly modified and served as the model for the official Royal Aircraft Factory drawing that recorded the squadron's modifications. This drawing is dated April 7, 1917.

Birmingham 32 — J. M. BRUCE

Bridging that Gap

I READ with interest the article *Bridging that Gap*, by D. A. Whybrow, manager of the Channel Air Bridge Division of Air Charter Ltd, in your issue of December 11. I would point out, however, that the expected basic cost quoted at £650,000 for the AW.670 is presumably Mr Whybrow's own estimate and does not necessarily bear relation to what the cost is likely to be.

London SW1 — J. A. R. KAY,
Joint Managing Director, Hawker Siddeley Aviation Ltd

[Asked if he would care to comment, Mr Whybrow replied: "I exchanged letters with Armstrong Whitworth at the beginning of January and pointed out that £650,000 was the figure quoted to Mr Laker (managing director of Air Charter Ltd) and myself early in 1959 when we were invited to visit the Armstrong Whitworth factory to see the detailed project for the AW.670."—Ed.]

Airline Safety

YOUR comments on the relative safety factors of the corporations and the independent airlines (*Britain's Airline Safety Record*, January 22) gave a number of valid reasons for the latter's *apparent* lower safety record; but one important aspect was entirely overlooked—that of the stage-lengths of routes operated.

BOAC, for example, have no really short-haul services, and once one of their machines is airborne for a 3,000-mile flight there can be little cause for accident. In 3,000 miles the pilot makes one take-off and one landing, but on many of the shorter routes flown by the independents, one aircraft over the same mileage possibly completes ten or more arrivals and departures, often into and out of aerodromes (I use the word specifically, instead of "airports") that would cause many a corporation captain to lose his night's sleep.

After all, when accidents *do* occur (fortunately, very rarely) they are usually associated with the take-off, climb-out, let-down, approach or landing; so if, therefore, we measure our accident rate in terms of scheduled flights successfully completed, then the tables are turned and the much-maligned independent companies come to the fore with a safety record that must be the envy of any nationalized airline.

Elstree, Herts — DAVID F. OGILVY,
Manager, Derby Aviation Ltd

FORTHCOMING EVENTS

Feb. 5. RAes Rotorcraft Section: "Vertical Transport Business," by R. L. Cummings.
Feb. 6. "Conquest of Space," by Mrs A. Masevich, Royal Festival Hall, London (and at Birmingham on 8th, Bristol on 9th and Manchester on 12th).
Feb. 8. Institute of Transport: Brancker Memorial Lecture, "RAF Transport Command," by Air Chief Marshal Sir Denis Barnett.
Feb. 9. RAeS: "Model Testing in the Aircraft Research Association Co-operative Wind Tunnels," by E. C. Carter.
Feb. 10. British Institution of Radio Engineers (Newcastle-upon-Tyne Branch): "Instrumentation in Rocket Propulsion," by Raymond E. Ross.
Feb. 12. RAeS Agricultural Aviation Group: "Choice of Aerial Vehicle," by F. R. J. Britten and D. F. Myres.
Feb. 16. Photogrammetric Society: "The Re-survey of the Highlands by Photogrammetric Methods," by Maj A. J. D. Halliday.
Feb. 17. RAeS (Main Lecture at Bristol Branch): "Firestreak," by G. H. F. Brown.
Feb. 18. RAeS Astronautics and Guided Flight Section: "Missile Control Problems," by D. Best.
Feb. 19. Institute of Navigation: Discussion on Space Navigation, introduced by Dr J. G. Porter.
Feb. 22. RAeS: Trenchard Memorial Lecture (at Halton Branch), "A Dip into the Future . . ." by Sir George Edwards.
Feb. 23. RAeS: "Theory and Practice in Structural Problems," by A. J. Troughton.

RAeS Branch Fixtures (to Feb. 12): Feb. 10, Chester (Joint meeting with Stanlow Branch of the Institute of Petroleum), "Bitumen and its Application to Runways," by G. P. Jackson.